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MANUAL

OF

DISEASES OF THE EAR

FOR THE USE OF
STUDENTS AND PRACTITIONERS OF MEDICINE

BY
THOMAS BARR, M.D.
SURGEON TO GLASGOW HOSPITAL FOR DISEASES OF THE EAR; LECTURER ON AURAL
SURGERY, ANDERSON'S COLLEGE; DISPENSARY SURGEON FOR DISEASES
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GLASGOW HOSPITAL FOR SICK CHILDREN, ETC.

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Dedicated to

SIR JOSEPH LISTER, BART., LL.D., D.C.L., F.R.S.,

AS A TOKEN OF ADMIRATION AND GRATITUDE,

BY ONE OF HIS GLASGOW PUPILS.

PREFACE.

THE object of this Manual is to present the main facts of Aural Surgery in a form sufficiently concise and methodical to meet the wants of General Practitioners and Students of Medicine. In its preparation I have not confined myself to my own experience, but have freely availed myself of information derived from the best works on this subject. I have especially laid under contribution the writings of Politzer, von Tröltsch, Gruber, and Urbantschitsch, who have done so much to give exactness to our knowledge of Diseases of the Ear. I must be content with this general acknowledgment of my indebtedness to these authors, as I have desired to avoid repeated and frequent references, which would only distract the attention of those who may use this Manual. For the guidance of any seeking a more intimate acquaintance with the literature of Aural Surgery, I have appended a list of the books which are most worthy of their attention.

My experience as a teacher in the Glasgow Western Infirmary and in Anderson's College, has convinced me that the time the student can devote to Diseases of the Ear would be more profitably spent in purely Clinical work, than in attendance on systematic lectures. Teaching, to be efficient in this branch, must be *practical*. The study of such a Manual as this will, I hope, prepare the student for the work of the Clinical class, and allow the lecturer to devote himself almost exclusively to the demonstration of cases and methods, and to practical instruction in the treatment of Ear Diseases. I hope, also, that this work will be of service to the General Practitioner, by enabling him to interpret the symptoms presented in morbid conditions of the Ear, and to adopt the most reliable methods of treatment.

According to the plan of this Manual, Diseases of the Middle Ear, as befits their frequency and importance, are much more fully described than those of the Auricle and External Auditory Canal, or of the Inner Ear. As there is, probably, no affection of the Ear that occurs so frequently, or is fraught with such important consequences, as chronic suppurative inflammation of the Middle Ear, the consideration of this disease and its consequences occupies a proportionately large part of the volume. The "Examination of the Ear," the

"Causes of Ear Disease," the "Affections of the Nose and Throat in their connection with Disease of the Ear," and the "Methods of Treatment," are taken up in a general way in introductory chapters. This arrangement obviates repetition, when the individual Diseases of the Ear are afterwards described, while it also presents a comprehensive view of these aspects of the subject. The remedies recommended for the various diseases described in this work are gathered together in a list of Formulæ at the end. For convenience of reference I have endeavoured to render the Index as full and complete as possible. This, it is hoped, will add to the practical usefulness of the work. I have purposely avoided the introduction of narratives of cases. These would not only be inconsistent with the scope and purpose of a Manual, but they would either increase the volume to undue dimensions or exclude other and more essential matter.

The illustrations employed are mostly original. Two of them, showing the microscopic structure of an aural polypus, were drawn by Dr. John Wilson, for whose kindness I feel grateful. Such of the illustrations as are taken from existing works are, I hope, duly acknowledged.

I feel deeply indebted to my friend Dr. Finlayson for many valuable suggestions. My warmest thanks are also due to Dr. C. Fred. Pollock for important assistance received from him in the performance of my task.

The whole of the woodcuts have been drawn and engraved by Mr. Stephen Miller, who is already so well known in connection with medical engravings.

T. B.

7 Albany Place, Glasgow,
1st *May*, 1884.

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PART FIRST.

INTRODUCTION.

CHAPTER I.—THE EXAMINATION OF THE EAR.
CHAPTER II.—CAUSES OF EAR DISEASE.
CHAPTER III.—AFFECTIONS OF THE NOSE AND THROAT IN THEIR CONNECTION WITH DISEASE OF THE EAR.
CHAPTER IV.—METHODS OF TREATMENT.

MANUAL

OF

DISEASES OF THE EAR.

MAIN ANATOMICAL AND PHYSIOLOGICAL DIVISIONS.

In the organ of hearing the physiologist recognises—1st, the peripheral part, for the conduction of sound; and 2nd, the central part, more immediately connected with the perception of sound.

The part for the conduction of sound is divided by the anatomist into the external and the middle ear. The external ear is subdivided into the auricle and the external auditory canal; the middle ear is subdivided into the tympanum, the Eustachian tube, and the mastoid cells.

The part for the perception of sound is called the inner ear. This includes the labyrinth and the auditory nerve, the labyrinth being divided into the vestibule, the semicircular canals, and the cochlea. These contain the labyrinthine fluid and certain membranous structures, which support the terminal ramifications of the auditory nerve.

The external is separated from the middle ear by the tympanic membrane, while the inner ear is separated from the middle ear by the membrane of the fenestra ovalis and the membrane of the fenestra rotunda.

The more detailed description of the structure and function of each of these sections of the ear will be found in connection with the consideration of the diseases of the parts. This will better serve the practical scope of this work, than a complete anatomical and physiological description of the organ introduced as a separate and independent section.

CHAPTER I.

THE EXAMINATION OF THE EAR.

I.—THE METHODS OF EXAMINING THE EAR THROUGH THE EXTERNAL AUDITORY CANAL.

THE auricle and the opening of the external auditory canal are seen sufficiently well in good light by simple inspection. By pressing the tragus forwards, and pulling the auricle upwards and backwards, we may also see with the unaided vision, if the canal is wide and free from obstruction, a large extent of the external auditory canal, and even a portion of the tympanic membrane. In most cases, however, in order to survey in all their detail the deep parts of the external auditory canal and the outer surface of the tympanic membrane, we require—1st, to remove or turn aside any obstructions in the canal of the ear; 2nd, to straighten the curve of the canal; and, 3rd, to reflect light into the interior.

The view of the deep parts of the ear is very frequently obstructed by particles of cerumen, epidermic scales, purulent secretion, &c. The cotton holder (Fig. 1) is the safest

FIG. 1.—Cotton Holder.

instrument to employ in removing such substances. It consists of a piece of iron or steel wire, the one end of which is fixed to a small wooden handle, while the other end is wrought into the form of a fine screw, round which, before use, a piece of cotton is firmly wound into a cylindrical shape. If syringing is used, as for instance in removing purulent secretion, the interior of the ear must afterwards be carefully dried with cotton, applied by means of the cotton holder. Metallic instruments, such as forceps or a probe, must be used with caution, and generally only when the inside of the ear is properly illuminated, so that the eye may guide the hand.

By the introduction of a proper kind of instrument—the aural speculum—the curved external auditory canal must be made as straight as possible, and any hairs which may occupy the entrance pushed aside. The aural speculum is a funnel-shaped tube, about an inch and a half in length, composed of either silver (Fig. 2) or vulcanite (Fig. 3). Of the metallic kind the most suitable is that known as Gruber's, which has an oval lumen at its narrower or inner end. Four sizes are necessary in order to fit the various widths of the external canal of the ear in different persons

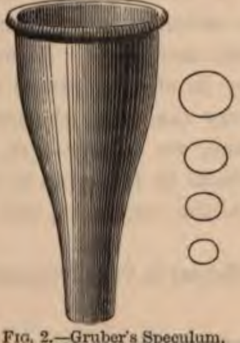

Fig. 2.—Gruber's Speculum.

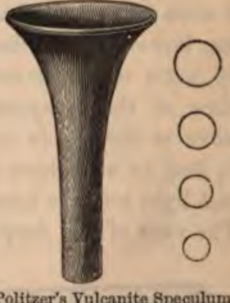

Fig. 3.—Politzer's Vulcanite Speculum.

and at different ages. Vulcanite specula have the advantage over metallic ones of being lighter, warmer, and not liable to be acted upon by the caustic substances, which it may be necessary to apply to the ear. The bi-valve aural speculum possesses no advantages over the simple tubular one, while it is apt to cause pain and injury to the ear. For the same reason long specula are to be avoided.

The best method of illuminating the interior of the ear is by reflecting light from a concave mirror. This simple, convenient, and effective contrivance for illuminating the interior of the ear was introduced by von Tröltsch, of Würzburg. The mirror should have a diameter of about two and a half inches, be perforated by a small hole in the centre, and have a focal distance of from three to five inches. It is either used with a handle (Fig. 4) screwed on to the metallic back of the mirror, or, if the right hand requires to be free, as in operating, it is attached to a head-band (Fig. 5) by means of a ball and socket joint, and is thus supported in front of the eye of the operator. For hypermetropic persons a proper convex lens may be fitted behind the perforation in the mirror. A flat mirror is necessary, when we wish to employ the direct rays of the sun.

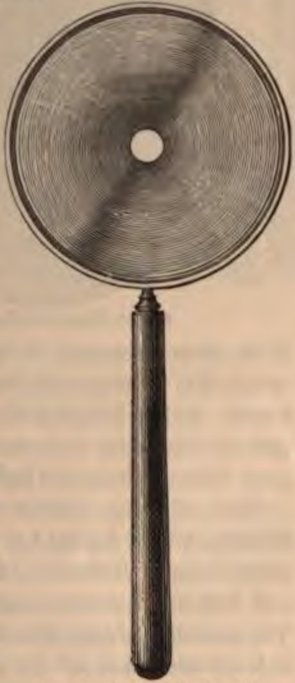

Fig. 4.—Concave Perforated Mirror with Handle.

Bright diffuse daylight, especially the light reflected from white clouds or a white wall, affords the best illumination.

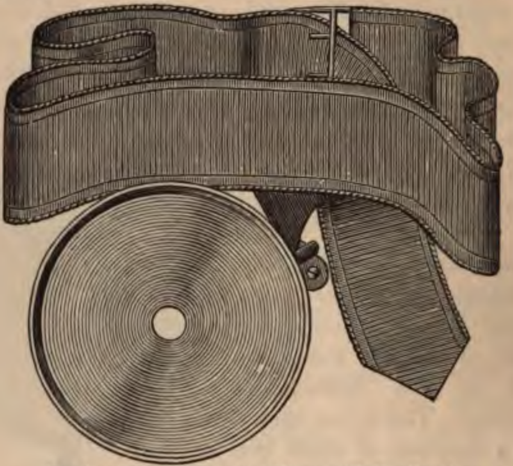

FIG. 5.—Concave Perforated Mirror with Headband

It is often necessary, however, to employ artificial light, which, it is to be noticed, imparts a reddish-yellow tint to the parts. Either lamplight or gaslight will serve the purpose, and in the latter case an Argand burner, having a long glass tube covering the light, should be preferred.

The reflecting mirror and ear speculum are used as follows: When daylight is available, the patient should be seated near a window, between the examiner and the light, and with the ear to be examined *turned away* from the light. The examiner should likewise be seated, his head being on a level with that of the patient (Fig. 6). In employing artificial light the lamp should be placed a little in front of, or a little behind the patient's head, slightly higher than the level of the ear, and should be arranged so as to allow the light to be easily reflected by the mirror into the interior of the ear.

Before attempting to introduce the speculum it is well to reflect light into the external orifice of the ear, so as to get an idea of the width and condition of the canal as a guide in selecting the size of the speculum required. This precaution is also necessary in case the canal of the ear should happen to be acutely inflamed, when the attempt to introduce a speculum would be attended by intense pain.

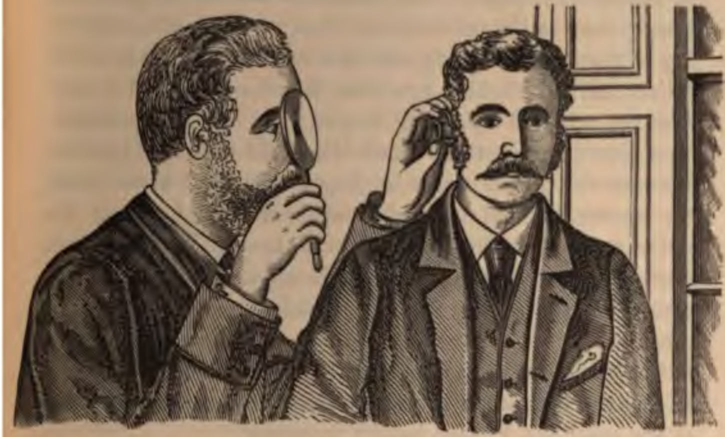

FIG. 6.—Examination with the Mirror and Speculum.

In introducing the speculum (which should be as wide as can be accommodated in the canal of the ear) the auricle is to be held upwards and backwards with the left hand, while the speculum, held at its outer edge between the thumb and first two fingers of the right hand, is passed by a sliding and turning movement into the canal of the ear for about half an inch, or as far as it will go without causing pain. In order to avoid the angular projection at the antero-inferior wall of the canal the speculum should be kept well in contact with the upper straight wall.

The examiner now takes the mirror by its handle in his right hand, and places the back of the reflector in contact with his right eyebrow, so that the hole in the mirror shall be opposite the pupil. The surgeon's head is brought sufficiently near to the patient's ear (four or five inches, according to the focal distance), and the reflecting surface of the mirror, turned slightly upwards, is moved in such a way that the reflected light shall be projected into the speculum. The speculum is at the same time held in proper position between the thumb and index finger of the left hand, while the auricle is held upwards and backwards between the index and middle fingers of the same hand. The speculum is then moved about in different directions, so as to pass in review all the parts of the tympanic membrane. If the speculum is not supported in this way, it will very likely fall partially out of the opening of the ear, and, instead of having the membrane in view, only some part of the walls of the canal will be seen by the examiner.

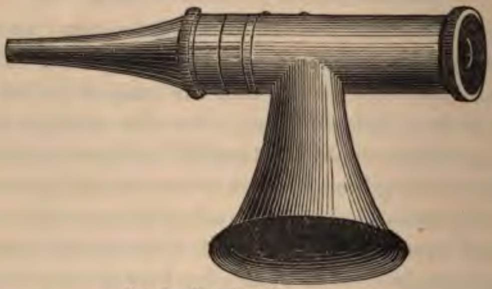

FIG. 7.—Brunton's Speculum.

Brunton's Speculum * is still pretty extensively used by practitioners in this country. It consists of a brass tube, furnished with an eye-piece at the one end, and an ear speculum at the other end (Fig. 7). The eye-piece has a lens of some magnifying power. The rays of light, natural or artificial, are admitted at the side through a wide funnel-shaped tube of polished silver, and fall upon a perforated mirror, which is set at an angle of 45 degrees in the interior of the tube. The light is reflected by this mirror through the speculum into the interior of the ear, from which it passes back through the perforated mirror and the convex lens to the eye of the observer.

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* See *Lancet*, 2nd December, 1865.

This instrument is much inferior in simplicity, convenience, and efficiency to the speculum and mirror just described. It cannot be recommended, not only on account of the comparative expense, but also because the interior of the ear is more apt to be injured by its use in inexperienced hands, and because of its limitation to diagnostic purposes. This last is its most serious disadvantage. It is highly important that an instrument, suitable for operation or manipulation as well as for examination, should be used by the student, for in this way the experience gained in the frequent examinations of the ear aids him very materially, when he comes to operative work.

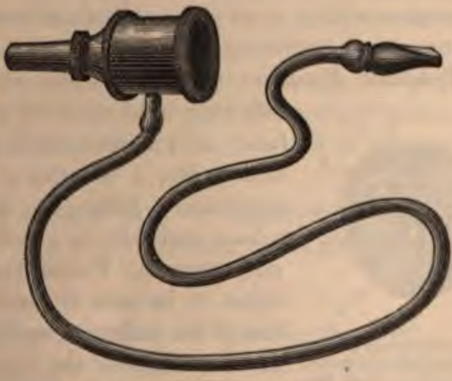

FIG. 8.– Siegle's Pneumatic Speculum.

Siegle's Pneumatic Speculum (Fig. 8) is of great value in the diagnosis of certain morbid conditions of the middle ear. It consists of a vulcanite speculum screwed on to one end of a vulcanite cylinder, which is closed at the other end by a plate of glass, or, if we wish to magnify the parts, by a convex lens. The side of the cylinder has an aperture, over which a perforated peg is fixed. To this peg is affixed an India-rubber tube, furnished at its other end with a mouth-piece made of horn, or with an India-rubber ball. The speculum is fitted air-tight into the external auditory canal, and, while we illuminate the interior by means of the mirror attached to the forehead, we alternately rarefy and condense the air in the canal, either with the mouth, or by compressing and relaxing the ball. In this way we ascertain the degree of mobility of the tympanic membrane, the presence of cicatrices or adhesions, and gain other useful information. It may be necessary to cover the end of the speculum with a short piece of India-rubber tubing, in order to make it fit the external auditory canal exactly.

The *Tympanic Membrane* (Fig. 9), when viewed by reflecting light upon its outer surface, as just described, presents, during life, a beautifully polished appearance, having a pearl-grey colour, and with a general concavity outwards. The most prominent object to be seen is the short process of the malleus, a small rounded white knob, near the upper border of the membrane, projecting towards the external auditory canal. From this a whitish ridge or stripe, sometimes having a tinge of yellow or red, is seen passing downwards, backwards, and slightly

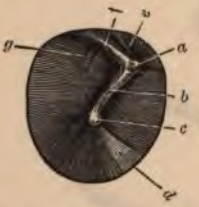

FIG. 9.—Outer aspect of right tympanic membrane—double the natural size: *a*, short process; *b*, middle of manubrium; *c*, umbo; *d*, cone of light; *e*, membrana flaccida; *f*, posterior fold; *g*, long process of incus shining through the membrane.

inwards to a point somewhat below the middle of the membrane, where it expands into a spatula-shaped extremity termed the umbo. This stripe or ridge is the manubrium, or handle of the malleus, shining through the outer and middle layers of the membrane. If the line of the manubrium were prolonged to the lower edge of the membrane, the latter would be divided into an anterior and a posterior part, of which the posterior would be the larger. Extending from the lower end of the manubrium downwards and forwards to the antero-inferior margin of the membrane, there is seen a specially bright reflection of light, called the cone of light, having usually a triangular shape, with the point towards the umbo. From the short process of the malleus we also notice a distinct ridge, formed by a fold of the membrane passing backwards to the periphery—this is the posterior fold. A smaller and less distinct fold—the anterior—is seen in front of the short process. The part of the membrane situated above the short process, and above these two folds, is known as the membrana flaccida. In many persons we see also the long process of the incus shining through the membrane as a whitish streak, parallel with and slightly behind the upper part of the manubrium.

II.—THE METHODS OF EXAMINING THE EAR THROUGH THE EUSTACHIAN TUBE.

These methods are—

(*a*) Catheterization of the Middle Ear.
(*b*) Politzer's Method of Inflating the Middle Ear.
(*c*) Valsalva's Method of Inflating the Middle Ear.

(*a*) *Catheterization of the Middle Ear.*

This consists in passing a suitably-formed tube—the ear-catheter—through the inferior meatus of the nose into the pharyngeal opening of the Eustachian tube (Fig. 10), and then forcing a current of air through the catheter.

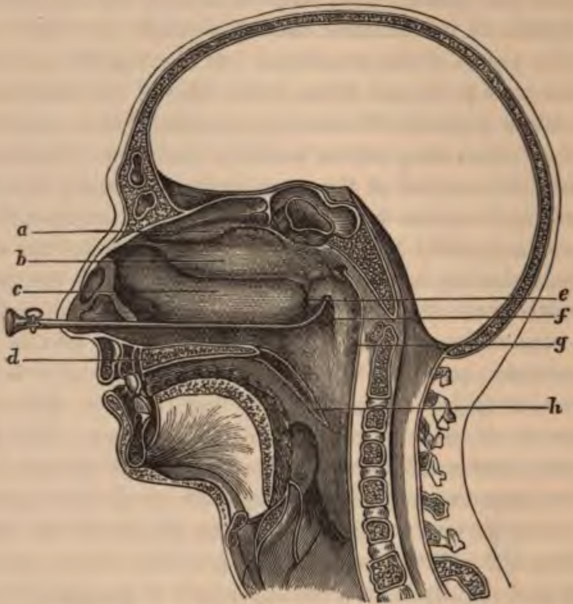

FIG. 10.—Vertical section of head, showing catheter introduced into the mouth of the Eustachian tube (after Politzer): *a*, superior spongy bone; *b*, middle spongy bone; *c*, inferior spongy bone; *d*, hard palate; *e*, posterior end of inferior spongy bone; *f*, mouth of Eustachian tube, with bulging above and behind; *g*, Rosenmüller's fossa; *h*, soft palate.

The ear catheter (Fig. 11) is a tube, made of either silver or vulcanite, curved at the one end as seen in the figure.

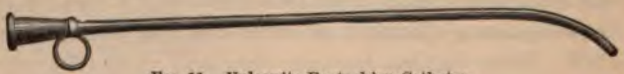

FIG. 11.—Vulcanite Eustachian Catheter.

The outer end is widened into a funnel-shaped opening, which fits on to the mouth-piece of an India-rubber bag, while the inner end is narrow for insertion into the mouth of the Eustachian tube. A catheter of medium size has a length of six and a half inches, and a free diameter at the outer end of a quarter of an inch, and at the inner end of one twelfth of an inch. The beak should measure an inch in length, and should form an angle of 135° with the rest of the catheter. In order to suit the varieties in the capacity and form of the inferior meatus and of the naso-pharynx, it is necessary to have a number of catheters differing in thickness and in the length and degree of curvature of the beak. The most efficient catheter is one, which is pretty wide, and has a strongly curved beak. A ring is attached to that side of the outer end of the catheter, which corresponds with the direction of the point of the beak, so that, when the catheter is introduced, the situation of the ring informs the operator of the position of the beak.

Vulcanite catheters possess several advantages over those made of silver. They are not injured by fluids injected through them. They are less unpleasant to the patient, and by their elasticity the operator can more easily evade obstructions, which may exist in the nasal passages. Besides, vulcanite catheters are much cheaper, and the practitioner can therefore have a greater number and variety of them than of the expensive silver ones. In an emergency the length and direction of the beak can be easily altered to suit any particular patient by slightly heating the catheter over a flame, and bending it as required. Before using a catheter it is well to test its permeability by forcing a stream of air through it.

Both patient and operator should be seated, the face of the former being well exposed to the light. As most patients tend to move the head backwards, while the catheter is being introduced, the back of the head should rest against some firm support. The four fingers of the surgeon's left hand rest on the patient's forehead, while the thumb gently presses up the tip of the nose.

The *first* stage of the operation consists in passing the instrument through the inferior meatus of the nose, till the point of the beak is felt to be in contact with the posterior wall of the naso-pharynx. The catheter is held like a pen between the thumb and first two fingers of the right hand, and the point of its beak is placed within the external orifice of the nose, so that the instrument forms an acute angle with the lower part of the face. The operator should then at once raise the catheter to the horizontal position, placing the point carefully in contact with the *floor* of the nasal passage, which, it is to be remembered, is under the level of the inferior edge of the nasal entrance. The instrument should now be pushed carefully, but not too slowly, along the inferior meatus, until its point touches the hard posterior wall of the naso-pharynx. When introduced properly, the outer part of the catheter forms a right angle with the face. If it has slipped into the middle meatus—the most common mishap of the beginner—it will form an *obtuse* angle with the upper part of the face, while in this position great pain is excited. In order to avoid this mistake the surgeon must *keep the catheter in the horizontal position, with the point of its beak in contact with the floor,* while it is being passed. In most cases very little difficulty or pain attends this part of the operation. When any difficulty is met with, an inspection of the nasal passage, by means of a mirror and speculum should be made, so as to ascertain if possible the exact nature of the obstruction. It will usually be found that the free space between the outer and the inner wall of the nasal passage is encroached upon, or even obliterated, either by bulging of some part of the nasal septum to one side, or by an abnormally large and projecting inferior spongy bone, or by swelling of the whole extent of the nasal mucous membrane. Nasal polypi more rarely form obstructions to the introduction of the catheter. By a little manipulation the surgeon is frequently able to overcome these difficulties. If the hindrance is produced by a large and prominent spongy bone, the point of the catheter should be turned outwards, so as to get it under the bone, where less resistance is met with. Success is sometimes achieved by directing the point upwards, or by insinuating the catheter in a spiral fashion. If these changes in the position of the catheter are not sufficient to overcome the difficulty, a thinner catheter, and one having a smaller curve, should be tried. If all of these expedients fail, the catheter may be introduced through the opposite nostril. In this case an instrument is used having a very long beak and a pretty strong curve. Such a catheter is passed in the way already described, and the point is then turned inwards and withdrawn, till the beak is felt to be in contact with the posterior edge of the septum, when the point will be near to or in the mouth of the Eustachian tube of the opposite side, that is, the side upon which we wish to operate.

The *second* stage of the operation consists in moving the point of the catheter from the posterior wall of the pharynx to the mouth of the Eustachian tube. This may be done in several ways. 1st, By Kramer's method, in which the catheter is withdrawn for from a quarter to half an inch, and the beak turned outwards, until the ring of the catheter is directed to the auricle of the same side. As the distance between the posterior wall of the pharynx and the mouth of the Eustachian tube varies in different persons, it is found that by this method the point of the catheter frequently lies in front of or behind the mouth of the tube, more frequently the latter, when it rests in the fossa of Rosenmüller. 2nd, Gruber's method consists in withdrawing the catheter till the beak is felt to embrace the soft palate. The point is then turned outwards, as in Kramer's method. The distance between the posterior wall of the pharynx and the edge of the soft palate presents great varieties during the movements of the palate, so that this method is also uncertain. 3rd, Politzer turns the point of the catheter outwards into the fossa of Rosenmüller, and then, keeping the point in contact with the mucous membrane, he withdraws the catheter, until its point is felt to pass over the usually well-marked rounded projection forming the posterior lip of the mouth of the tube. This method is generally the simplest and most certain. 4th, Löwenberg's plan consists in turning the point of the catheter inwards *towards the opposite side* and then withdrawing it, until the beak hooks round the posterior edge of the nasal septum. The catheter is now rotated downwards and outwards, so as to describe a half circle, when the point is usually at the mouth of the tube. Both Politzer's and Löwenberg's methods possess the advantage of having well marked and fixed anatomical guides — namely, the cartilaginous projection behind the mouth of the Eustachian tube, and the posterior edge of the nasal septum, respectively. These methods are therefore to be preferred to those of Kramer and Gruber. When the point of the beak is at the mouth of the tube, the external end of the catheter should be gently pressed against the nasal septum, and the ring turned up towards the auricle of the same side. This forces the point well into the mouth of the Eustachian tube.

There is sometimes some difficulty in turning the beak of the catheter. This may be due to an unusually small space existing between the posterior edge of the nasal septum and the mouth of the tube, owing to peculiarity of formation. Or the free space of the upper pharyngeal cavity may be diminished by great swelling of the mucous membrane, or by the presence of so-called adenoid vegetations. We can overcome these difficulties by using a catheter having a short and slightly curved beak. Spasmodic contractions of the pharyngeal muscles may seriously hinder the turning of the catheter. The spasm generally passes off, when the patient breathes deeply a few times through the nose. The contact of the catheter with the mucous membrane of the nose or pharynx sometimes excites coughing, sneezing, or retching; but it is sufficient simply to let go the catheter until these pass off.

When the catheter has been properly introduced, it is retained *in situ* most conveniently by being held between the thumb and index finger of the left hand, while the hand is steadied by resting the other three fingers on the forehead and bridge of the nose (Fig. 13). If both hands of the surgeon require to be free, as in the application of vapours to the interior of the middle ear, the catheter may be held in position by Bonnafont's nasal clamp, or by the patient himself. A simple and efficient form of clamp can be readily made by heating a strip of whalebone, and bending it into a shape something like the letter M, with long limbs; an elastic band serves as a spring to draw the limbs together against the sides of the nose. There is occasionally slight bleeding from the vascular membrane, with which the catheter is in contact, but rarely more than a stain of blood on the beak of the catheter is seen.

While the surgeon, who is accustomed to perform catheterization, is frequently able to satisfy himself by touch alone that the catheter is properly introduced, it is better to prove by actual inflation and auscultation that the point of the catheter is properly inserted into the mouth of the Eustachian tube.

After use, the catheter must be thoroughly syringed out with warm water containing Condy's fluid or carbolic acid.

The importance of this precaution has been demonstrated by several cases, in which secondary syphilis has been transmitted through the medium of the catheter. After its use in a syphilitic patient the same catheter should not be again employed till it has been immersed in a disinfecting solution for 24 hours, and then thoroughly cleansed inside as well as outside. When a patient requires the frequent and long-continued application of the catheter, it is well, in order to avoid any possible risk, to provide a catheter, which shall be kept exclusively for him. The cheapness of vulcanite catheters removes any objection to this on the ground of expense.

The ear catheter may be looked upon as a tubular prolongation of the Eustachian tube, and as thus providing a channel by which gases, liquids, or solids may be introduced into the middle ear. A current of air is most frequently used; but warm water, warm medicated liquids, medicated vapours and gases, laminaria tents, bougies, and electrodes are also employed. We shall at present confine ourselves to the consideration of the use of compressed air as a method of diagnosis.

In order to force air into the catheter a pear-shaped India-rubber bag or balloon, of a size capable of containing eight or ten ounces of fluid, is required (Fig. 12). This bag is furnished with a tubular mouth-piece, made of horn or vulcanite, and somewhat conical in shape, so as to fit accurately into the

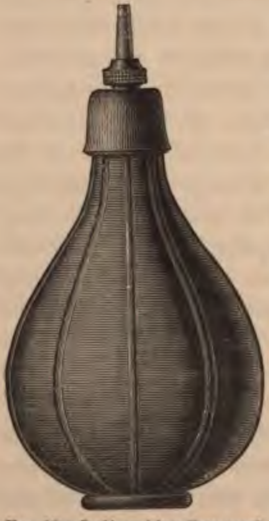

FIG 12.—India-rubber Bag used for inflation.

funnel-shaped opening of the catheter. Some surgeons interpose a soft India-rubber tube between the mouth-piece of the bag and the catheter, in order to avoid any risk of forcing the point of the catheter inwards upon the mucous membrane. While the catheter is being introduced, the air-bag may be conveniently held in the left arm-pit of the surgeon.

The catheter having been introduced by one of the methods described, and being retained in position by the left hand, the air-bag is grasped by the right hand in such a way that the thumb and four fingers embrace or encircle the lateral parts of the bag. The mouth-piece of the bag is placed in the outer opening of the catheter (Fig. 13), and the bag is then firmly compressed between the four fingers and thumb, so as to force the air into the catheter. Before relaxing the hand the mouth-piece of the bag should be withdrawn from the catheter, and then the bag allowed to fill with air. Five or six compressions of the bag are generally sufficient, although in cases of great obstruction to

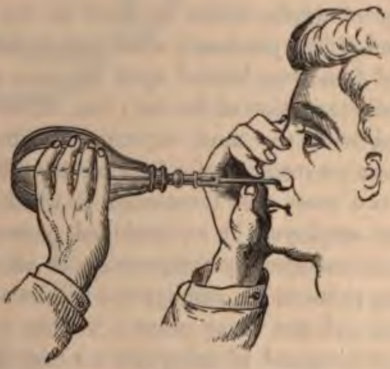

FIG. 13.—Catheterization.

the passage of air through the Eustachian tube, ten or twelve may be required. The surgeon must be careful not to press the bag too strongly or quickly, till he is convinced by the sensation of resistance that the point of the catheter is really between the lips of the tube, and not pressing on the mucous membrane. He must also be careful during the compression of the bag not to push the catheter inwards, and thus violently force the point upon the mucous membrane.

If during compression of the air-bag the point of the catheter is forced through the mucous membrane, or if it is pressed upon an ulcerated surface, the air may pass under the mucous membrane, and produce emphysema of the neighbouring parts, such as the soft palate, uvula, or cheek. In two cases of death, which occurred in the hands of a London quack thirty years ago, after catheterization of the ear, the fatal issue was looked upon by some as a serious danger in catheterization of the ear; but, while emphysema has occurred with the most experienced aural surgeons, there has been no instance of a fatal result with the exception of the two cases just mentioned, in which a powerful air-pump was employed by an unskilled person. If air is forced into the catheter by compression of an air-bag with the foregoing precautions, emphysema will be an extremely rare accident, and can never prove a serious complication. Some surgeons, instead of using the air-bag, blow air into the catheter with the mouth. This is an objectionable as well as an inefficient method. The use of a compression-pump is rarely, if ever, necessary.

Auscultation of the Ear.—The inflation of air through the catheter yields valuable information as to the condition of the Eustachian tube and the tympanic cavity. This information is derived mainly from the kind of sound produced by the current of air in the middle ear. In order to hear these sounds the surgeon must auscultate the ear during the passage of the current, and for this purpose the external auditory canal of the patient is connected with the external auditory canal of the surgeon by an India-rubber tube, thirty inches long, termed the otoscope (Fig. 14), or more correctly the diagnostic tube. This tube is furnished at each end with an acorn-shaped ear-piece, made of horn, or vulcanite, or ivory, one for the use of the surgeon, and the other for the patient. These ear-pieces should have distinctive colours, in order that the one for the patient may not be used by the surgeon. Nothing should be allowed to touch or press upon the diagnostic tube when in use, in case of interfering with the passage of sound from the patient's ear to the surgeon's.

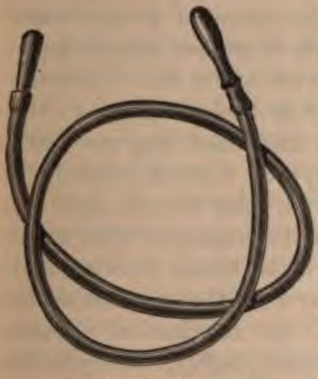
Fig. 14.—The Otoscope.

In the normal state of the middle ear the sound heard during inflation has a distinctly blowing character, conveying to the listener the impression as if originating close to his own ear, and as if caused by air striking against a soft yielding membrane. This sound is compared by Politzer to that produced, when we place the tongue near to the hard palate, and make a quick expiration, with the lips slightly apart.

In pathological states of the ear a variety of modifications of this sound are heard. If the mucous membrane of the middle ear is abnormally dry, while the Eustachian tube is wide,—conditions found in sclerosis of the middle ear—the sound has a full, hard, and dry character. When the tympanic membrane is drawn in, as in simple swelling of the pharyngeal mouth of the Eustachian tube, a full thudding sound is heard, caused by the stretching out of the membrane.

Rattling sounds or râles are not unfrequently heard. They are produced either by the air passing through fluid secretion, or by the friction of the current of air upon some solid obstructing substance, such as swollen mucous membrane, dried secretion, organised adhesions, &c. When the râles appear to be distant, they probably originate in the Eustachian tube; when, on the other hand, they are heard as if produced in our own ear, their source is probably in the tympanic cavity. When the râles have a moist or bubbling character, they indicate the presence of fluid secretion in the middle ear. It is to be noted, however, that small quantities of secretion may be in the tympanic cavity without any râle being heard on auscultation. Loud, rattling sounds, like an *r* pronounced roughly, which may be heard even without the use of the diagnostic tube, are often produced at the pharyngeal mouth of the tube, either by the vibration of the lips of the tube, especially if the catheter is not in proper position, or by the action of the current of air upon the viscid mucus frequently found there. In the latter case the sound is usually only heard at the beginning of the inflation.

The sound heard by auscultation may be thin, weak, distant, interrupted, and attended by a sibilant tone of greater or less intensity and pitch. Assuming that a medium-sized catheter has been used, and that it has been properly inserted into the Eustachian tube, such an auscultation sound generally indicates some form of obstruction in the Eustachian tube or tympanic cavity. The obstruction may be caused by swelling or thickening of the mucous membrane, by dried secretion, by agglutination of the mucous walls, or by organized adhesions. In such a condition a fuller and stronger stream of air is frequently heard to pass into the tympanum, if the patient swallows during the compression of the air-bag. In this way the surgeon obtains the aid of the tensor palati muscle in separating the outer wall of the cartilaginous part of the Eustachian tube from the inner.

In perforation of the tympanic membrane the auscultation sounds are often very characteristic. If the perforation is small, and there is fluid secretion in the tympanum, a loud whistling or hissing sound, which may be heard by the bystander without a diagnostic tube, is generally heard, provided the Eustachian tube is freely permeable. A similar sound may be heard, when the perforation is large, if the calibre of the Eustachian tube, especially of the tympanic end, is diminished by swelling of the mucous membrane. If the Eustachian tube is wide, and a large part of the tympanic membrane is destroyed, a blowing sound is heard, pretty much like the normal sound, but conveying a stronger impression to the ear of the auscultator. The sounds heard in perforation or destruction of the tympanic membrane have this in common—that they convey to the listener the sense of great nearness, almost as if produced in his own ear, and this is sometimes so marked as to be very disagreeable. When no sound whatever is heard, the catheter is probably not accurately introduced, or the diagnostic tube is obstructed.

In regard to the value of auscultation of the ear, as a method of examination, it may be said that, while by itself, without relation to other symptoms, it does not in most cases furnish us with decisive information of the pathological condition of the ear, there is no doubt that, taken in connection with other objective symptoms, it gives important help in the accurate diagnosis of a case.

In addition to auscultation, useful information may be derived during catheterization by inspection of the membrane, by the resistance offered to the hand in compressing the air-bag, and by the sensation of the patient. Inspection during inflation facilitates the diagnosis of immobility of the membrane, adhesions, atrophy, obscure perforations, and fluid secretion in the tympanic cavity. The resistance to the hand shows in some measure the amount of obstruction existing in the tube. When the air penetrates freely as far as the membrane, the patient feels as if the air passes *out of* the ear; on the other hand, when the air does not reach the tympanum, the patient can often say that the current only passes towards, but not so far as to the ear.

(*b*) *Politzer's Method of Inflating the Middle Ear.*

We pass now to the very important method of inflating the middle ear, named, after its discoverer, Politzer's method.

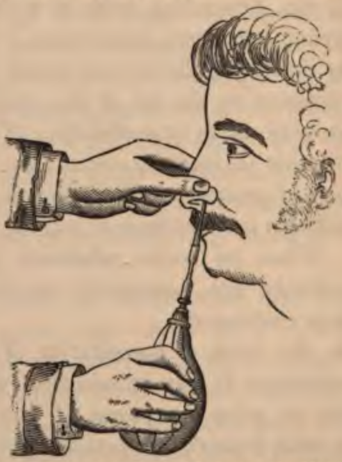

FIG. 15.—Politzer's Method of Inflating the Middle Ear.

Professor Adam Politzer, of Vienna, demonstrated in 1863 that the Eustachian tubes and the tympana can often be effectually inflated by a method tolerated even by the youngest children. This proceeding (Fig. 15), which is practised every day by those engaged in the treatment of ear diseases, consists in this:—After the patient has taken a small quantity of water into his mouth, the nasal piece of a tube connected with an air-bag is placed about one-third part of an inch into the nose, the nasal passage being completely closed in front by compressing the nostrils firmly with the thumb and index finger of the left hand. The air-bag is then grasped by the right hand; the act of swallowing the water is performed by the patient at the command of the operator; and, at the same moment, the bag is forcibly compressed, and suddenly emptied into the closed nasal cavity. The closure of the nasal cavity behind is effected in the act of swallowing by the elevation of the soft palate and its apposition to the posterior wall of the pharynx, while the sudden increase of density in the air contained in the shut nasal cavity, produced by emptying the air-bag, overcomes the resistance in the Eustachian tubes, and air passes freely into the tympana. In the act of swallowing, also, the contraction of the muscles of the Eustachian tube facilitates the passage of air into the tympanum.

In very young children the act of swallowing is often unnecessary for the success of the inflation. This peculiarity is due to the fact that the Eustachian tube in early childhood is shorter, wider, and more dilatable than in adult years. If the child cries, the inflation is made more effectual. Lucæ, of Berlin, pointed out that the utterance of certain sounds, especially the sound of "ah," was attended by the apposition of the posterior edge of the soft palate to the posterior wall of the upper pharynx; and Gruber, of Vienna, found, as the result of experiments, that the pronunciation of the syllables, "hick," "hack," or "huck," (pronounced "hook"), with emphasis on the final letter, was still more effectual in closing the posterior nasal cavity. This modification of Gruber is a good substitute in the case of children for the swallowing of water. It is simpler, and takes less time than the original method of Politzer. While a child learns easily and quickly to pronounce the word "hook," the explanations necessary in teaching the method, which requires the swallowing of water, and the considerable time usually required by the child in learning to swallow at the proper moment, are important considerations, especially in a large public dispensary. In some cases, however, the swallowing of the water seems to be more effectual than the phonation of "hook," and the writer rarely uses the latter in adults.

When we desire a greater effect to be exercised upon one ear, we may either close the opposite ear tightly with the finger, or cause the patient to incline his head well to the side on which the least effect of inflation is desired.

The bag used in Politzer's method may be the same as for catheterization. Several kinds of nasal pieces are employed. Politzer himself used one shaped like a catheter, and connected to the mouth-piece of the bag by means of a soft India-rubber tube, two or three inches in length (Fig. 16); but he has now discarded this as unnecessary, and prefers merely a short piece of common India-rubber tubing, about an inch long, half of this length being slipped over the end of the mouth-piece of the bag, and the other half being introduced into the nostril. The beak-shaped extremity of the hard nasal piece may be covered with soft India-

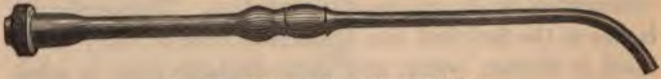

FIG. 16.—Politzer's Nasal Piece and Tube.

rubber tubing, which renders it less unpleasant, and less likely to hurt the nasal mucous membrane. A conically-shaped nasal piece, made of horn, and sufficient in size to fill up one nostril, is less disagreeable than the thin nasal piece, and is therefore specially suited for children and sensitive persons. When the conical nasal piece is inserted into one nostril, only the other need be closed with the finger, and thus the nostril is not pressed against the hard material. In the case of children the writer generally makes use of a nasal piece composed of thick soft India-rubber, somewhat flattened at the sides (Fig. 17). The pressure of the nostril upon this soft India-rubber causes no unpleasantness whatever. For self-use by the patient, the nasal piece is connected with an India-rubber tube, 15 inches in length, which is attached to the mouth-piece of an India-rubber bag. Dr. Peter Allen used a tube with two India-rubber nasal pieces, which were pressed over the nasal orifices—this avoids the unpleasantness of pushing the tube into the nostril; but, on the other hand, it is not so certain in its effects. An ordinary India-rubber enema-bag of six or eight ounces capacity, with a piece of soft India-rubber tubing covering its hard ivory mouth-piece, forms a ready substitute for the instruments required for the practice of Politzer's method.

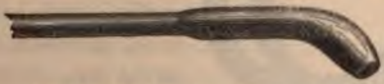

FIG. 17.—Soft Nasal Piece for Children.

In the treatment of children there is frequently substituted for the rather formidable-looking air-bag a simple India-rubber tube (Fig. 18), with a mouth-piece for the operator, and a nasal piece for the child, and, while the little patient pronounces "hook," or swallows water, the manipulator blows through the tube. This is a plan which can be both conveniently and safely practised by the parent of the child in the intervals between the visits of the surgeon. Occasionally pain in the stomach is set up, owing to insufficient closure of the pharyngeal cavity, and the consequent passage of air down the œsophagus; but this is immediately relieved by eructation, or by a few full inspirations. Now and then other disagreeable symptoms result from the practice of Politzer's method, such as pain in the head, giddiness, and singing in the ear. These untoward results, however, follow comparatively seldom.

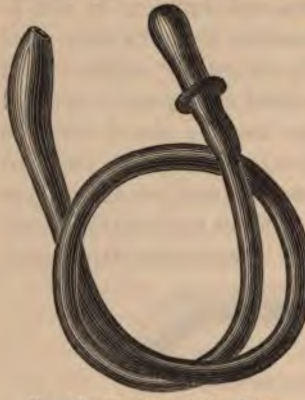

FIG. 18.—Simple Inflating Tube for Children.

When inflation by Politzer's method is successful, the patient has usually a sense of fulness in the ear, while on inspection the membrane is seen to bulge more or less outwards. The sense of resistance offered to the hand in compressing the bag helps the surgeon to estimate the perfection of the closure of the naso-pharynx posteriorly. Auscultation does not yield us so much or so distinct information by Politzer's method as by catheterization, for the sound caused by the act of swallowing the water muffles the weaker sounds in the ear. After long practice, however, the surgeon becomes more able to distinguish the sounds in the ear, and to separate them from external ones; and, further, if the surgeon is here disturbed by the act of swallowing the water, he has the advantage of not hearing the sound produced by the friction of the air in the catheter, or the vibrations at the mouth of the Eustachian tube. The practised surgeon is therefore often able to hear many of the sounds, which have been described as heard during catheterizing, almost as distinctly by auscultation with Politzer's method. Even the unaccustomed observer has no difficulty during inflation by this method in distinguishing the "perforation râle," or the well-marked thudding sound heard when the tympanic membrane returns to its proper position after having been drawn in from obstruction of the Eustachian tube.

(c) *Valsalva's Method of Inflating the Middle Ear.*

Valsalva's method of inflating the middle ear consists in making a forced expiration with the lips closed, and the nostrils firmly compressed with the fingers. In this way the air contained in the naso-pharyngeal space becomes more or less condensed in proportion to the strength of the expiratory muscles in the given case. Where the resistance offered by the walls of the Eustachian tube or by the tympanic membrane is inconsiderable, the condensed air passes through the Eustachian tube into the tympanic cavity. If we examine the membrane during a successful effort, we see an outward movement, especially at the postero-superior part. On auscultation a sound is heard resembling that produced, when air is blown out through the slightly closed lips. The patient has usually, at the same time, a sense of fulness and slight singing in the ear.

When the membrane is entire, and where there is much resistance offered by the walls of the Eustachian tube to the passage of air, Valsalva's method is usually quite ineffectual, and even in a normal condition of the middle ear many persons fail to inflate the ear by this method. Where the membrane is perforated, however, this method is more likely to be successful, in consequence of the diminished resistance, and the well-marked hissing sound caused by the passage of air through the perforation enables us in a simple and handy way to diagnose a perforation in the tympanic membrane.

Occasionally this method succeeds in inflating the middle ear after the catheter and Politzer's method have failed.

The Negative Valsalva's Method, or Toynbee's experiment, consists in swallowing some saliva several times, while the mouth and nose are closed. A rarefaction of the air in the naso-pharyngeal cavity is thus produced, and, provided the Eustachian tube is in a normal condition, some of the denser air in the tympanum will simultaneously pass into the naso-pharyngeal cavity. A sense of pressure, and sometimes a slight ringing, is experienced in the ear, which are removed when the patient swallows in the ordinary way. If we inspect the membrane during the experiment, it is sometimes seen to recede more or less inwards. With the diagnostic tube there is occasionally heard a slight crackling sound. Both the movement of the membrane and the sound by auscultation are, however, often absent, and, even where present, they do not necessarily indicate a permeable condition of the Eustachian tubes. Hence, on account of the uncertainty of its results, Toynbee's experiment is of very little diagnostic or therapeutic value.

There are certain contrivances, called ear-manometers (Fig. 19), for showing, by ocular demonstration, the changes in the density of the air in the middle ear produced by Toynbee's experiment or Valsalva's method. A simple form consists of a fine glass tube, having the shape of a horse-shoe. This is fitted air-tight into the external auditory canal by means of an India-rubber plug. A drop of red ink, or of a solution of carmine, is placed in the tube near its outer end. The falling and rising of the coloured solution indicate the fluctuations in the pressure of the air in the middle ear.

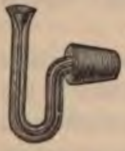

FIG. 19.—Ear-Manometer.

III.—THE METHODS OF EXAMINING THE AUDITORY NERVE AND LABYRINTH.

The basis of this examination is a comparison between the conduction of sonorous vibrations through the bones of the head, and their conduction through the ordinary conducting apparatus of the ear.

In testing sound-perception through the bones of the head, the tuning-fork is the most valuable instrument, although a loudly ticking watch, or Politzer's Hörmesser (Fig. 21), may be employed. In the latter case the ears should be closed by the patient's fingers, and the watch or Hörmesser applied first to the temple, and then to the mastoid process. If no sound is perceived, the watch should then be put between the teeth. The sound of even a loudly ticking watch may not be heard, when applied to the bones of the head, although the perceptive power of the auditory nerve is unimpaired; but, if a weakly ticking watch is clearly heard, this indicates that the sentient part of the ear is pretty healthy. If, on the other hand, the watch is not heard at all, while the Hörmesser is clearly heard, there is probably a diminution in the perceptive power of the nerve. Lastly, if the Hörmesser is not perceived, when applied to the temple or mastoid process, we may assume with great probability that the perceptive power is seriously impaired.

The tuning-fork, however, yields by far the most reliable results. If a vibrating tuning-fork be held close to the ear, but not touching it, the sound will be perceived in its fullest intensity; the vibrations, being conducted by the air to the tympanic membrane, produce the maximum amount of impression on the nerve. If the sounding fork be now placed on the top of the head, it will be heard clearly and distinctly in both ears, although not quite so loud, nor for so long, as in the first experiment. If both ears are now closed with the fingers, and we hold the vibrating fork opposite the ear, only a very faint sound will be appreciated; but, if we transfer it to the vertex, the tuning-fork will be heard sounding nearly twice as intensely as with the ears open. Again, allow one ear only to be closed, and place the sounding fork in contact with the cranial bones, and the effect will be very striking—the sound heard in the closed ear will be very much louder than in the open one—indeed, it will be so intensified on the closed side, as to give the impression that no sound is perceived in the open ear at all. Even though the fork, still in contact with the head, be moved close to the unoccluded ear, the sound will still be heard almost exclusively on the closed side. Similar exaggeration of the impression of sound may be noted in our own persons, when, in the act of speaking, we close our auditory canals; the vibrations of our vocal apparatus, transmitted by the cranial bones, will then affect our auditory nerves much more strongly. Lastly, if a watch be placed in the mouth, between the teeth of the upper and lower jaws, the sound of the ticking will be heard with much greater intensity when we close the ears with the fingers. It is noteworthy that, in stopping the ears, if the finger be pressed into the canal of the ear very firmly, the increase of sound is less marked than when there is closure with only slight pressure; or the sound, instead of being increased, may be actually diminished. The interesting fact, to which Weber was the first to direct attention, that when a vibrating tuning-fork is placed on the vertex, and the external auditory canal of one side is closed with the finger, the sound on that side is much intensified, affords a basis for the application of the tuning-fork for the purpose of differential diagnosis. A great amount of labour, by way of experiment and otherwise, has been expended to explain this phenomenon. Politzer gives the following explanation of the increased loudness of the sound on the occluded side:—1st, The increased resonance of the external auditory canal, and the reflection upon the tympanic membrane and ossicles of the vibrations transmitted by the bones of the head to the air in the external passage. 2nd, The hindrance to the passing away from the ear of the waves of sound conducted by the bones of the head to the labyrinth and tympanum. 3rd, The altered tension of the membrane and ossicular chain. This subject is fully treated of, along with that of the effect of very firm pressure in the meatus on osseous conduction, by Politzer, in the *Archiv für Ohrenheilkunde* for 1864.

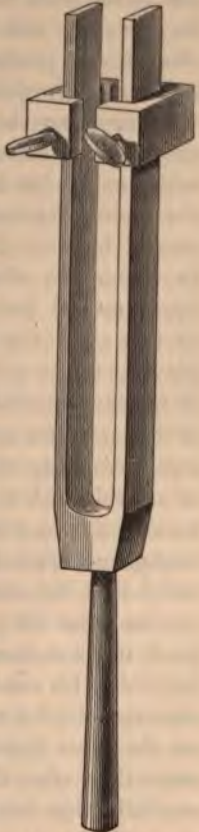

FIG. 20.—Tuning-Fork with Clamps.

The tuning-fork (Fig. 20) most useful for our purpose should be large-sized, and of the pitch C, with 512 vibrations in the second, fitted to produce a sound sufficiently long-continued to ensure that the patient has time to recognize on which side he hears the sound best. It yields two simultaneous sounds—the fundamental or deep tone, and the high tones or harmonics. The harmonics are usually appreciated more distinctly when the fork is held some distance from the ear; the fundamental tone predominates when it is held nearer. The harmonics are in great measure destroyed, when the limbs of the tuning-fork are grasped by two brass clamps. When these are attached, only one tone is appreciated, and that one, on account of the number of vibrations per second being diminished, is much lower in the scale. By shifting the clamps towards the handle we render the pitch higher, until, when we reach the lower end of the limbs of the fork, it is raised a complete octave. In this way one tuning-fork, with the addition of these clamps, can produce a variety of notes according to the position of the clamps.

In applying the tuning-fork, when we wish to compare the relative susceptibility of the two nerves, we may select any point in the middle line of the head, such as the vertex, forehead, bridge of the nose, upper lip, or the central incisors of the upper or lower jaw. The position in which the vibrations are heard loudest is over the upper central incisors, when the jaws are apart; but, as at this place the sensation of the vibrations is very unpleasant to the patient, the forehead or bridge of the nose is usually selected. The temple or the mastoid region is chosen, when our object is to determine the actual perceptive capacity of the nerve, and not to make a comparison of one side with the other. We may form a very fair estimate of this by comparing the patient's appreciation of the tuning-fork applied to the head with that of our own, provided that our nerves of hearing are normal. It may be assumed that the perceptive power of the patient is fairly good, if, the moment he has ceased to hear the sounding fork applied to his mastoid process, we quickly transfer it to our own and also fail to perceive it, or hear it only slightly. If, on the other hand, we can distinguish it clearly, and for some time after the patient no longers hears it, we may conclude that his auditory nerves have lost their normal susceptibility to sound. There is a source of error, against which we must be on our guard. The patient being preoccupied by the thought that he should hear the tuning-fork better on the good side, and worse on the deaf one, will probably, if not previously cautioned, at first say that he hears it better on the healthy side. In most cases, however, with moderately intelligent patients, we will, by a little exercise of patience, succeed in getting an accurate account.

The same effect, which is brought about by the experiment of stopping the ear with the finger, is produced by many of the diseases of the sound-conducting apparatus. The obstructions, due to pathological changes in the external auditory canal and tympanum, which prevent the entrance of the waves of sound of the fluid of the labyrinth, also intercept, in their passage outwards, those vibrations which have been conducted to the labyrinth by the bones of the head; and these vibrations, being reflected back on the nerve, intensify the sound of the tuning-fork. Hence, the vibrating fork may be only faintly heard, when held opposite to the dull ear; but, when transferred to the bones of the head, it will sound much more strongly, or even exclusively on that side.

This osseous conduction of sound, when the conducting part of the organ of hearing is diseased, may be turned to profitable account by patients, and the tones of a musical instrument, such as the piano, may sometimes be appreciated by a very deaf person, if a rod of wood, in contact at one end with some part of the instrument, be held at the other end between the teeth of the patient. In this way a melody, which would be a confused mass of sound under ordinary circumstances, may be heard clearly.

The obstructions in the auditory passages to the entrance or exit of waves of sound may consist simply of the presence of foreign substances, such as impacted cerumen in the meatus or catarrhal exudations into the tympanic cavity. The same effect is produced, however, by any cause which interferes with the vibrating or oscillating power of the membrana tympani and ossicular chain, such as their increased tension caused by the stronger effects of the atmospheric pressure on the outer surface of the membrane in obstruction of the

Eustachian tube, or in anchylosis of the ossicles to one another, or of the plate of the stapes to the edge of the fenestra ovalis. In these cases the waves of sound passing out from the labyrinth are impeded by the unyielding base of the stapes pressing on the fenestra ovalis. In the case of perforation of the membrane, the increased perception of sound, conducted by the bones, often observed, is due to other changes in the tympanum, such as thickening of the mucous membrane, rigidity of the ossicles, or presence of purulent secretion. *There are few exceptions to the rule that, if the vibrating tuning-fork, when applied to any point in the median line of the skull, is heard more strongly on the affected or deafer side, the nerve on that side is fairly healthy, and the patient is probably suffering from some one of the conditions just mentioned.*

On the other hand, if there is *diminished* perception of the tuning-fork on the affected or deafer side, indicated either by comparison with the opposite side, or by comparison with our own healthy auditory nerve, there is probably either some lesion of the auditory nerve, or some increased tension of the labyrinthine fluid, produced perhaps from the tympanic side, which diminishes either temporarily or permanently the perceptive power of the nerve. It is to be remembered that, as pointed out by von Tröltsch, in persons over fifty years of age, diminished perception of vibrations conveyed along the bones has not the same serious meaning as in younger people, for after that period of life it is often due to some change in the osseous tissue of the cranial bones, which impairs their conducting power.

The perceptive capacity of the auditory nerve is sometimes determined by the acoustic reaction to the galvanic current. Brenner asserts that there is a constant law of reaction of the nerve by sensations of sound to the galvanic current. When the negative pole is placed in fluid filling the canal of the ear, a loud sensation of sound is heard by the patient on closing the circuit, continuing till it is opened, when it ceases. On the other hand, if the positive pole is placed in the fluid, no sound is heard on closure, but a feeble sound is heard at the moment of opening. If the auditory nerve is abnormal, there is a deviation from this law. If a very weak current excites a loud sound, there is hyperæsthesia; if a strong current has little or no effect, there is dysæsthesia. These conclusions are denied by Schwartze, Wreden, Schulz, &c. And it may be said that the diagnostic value of the galvanic current in ear disease is still *sub judice.* For detailed reference to this subject see Urbantschitsch in his *Lehrbuch der Ohrenheilkunde.*

IV.—METHODS OF TESTING THE HEARING POWER OF A PATIENT.

Impairment of the function of hearing is one of the most frequent and important symptoms of disease in the ear. It is essential therefore to employ some means, by which we may determine the extent of the loss of hearing. The tests which are employed are (*a*) simple tones and (*b*) speech.

(*a*) Simple Tones.

Unfortunately we are not yet possessed of a universal standard, by which we may measure and compare the hearing power of an individual. The most convenient instruments for testing the capacity for hearing simple tones are the watch and Politzer's Acumeter or Hörmesser; but both of these are defective in this respect, that they only test the power of the ear for hearing one or two tones. The human ear is capable of perceiving a vast number of different tones or sounds; but in using the tick of a watch we are only testing with two particular notes, and it is quite conceivable that the power of hearing these two notes may be very defective, while the power of distinguishing many others may be comparatively good, and *vice versa*.

We must employ a watch the tick of which is a clear distinct sound, not a rubbing or shuffling tick. We must keep in mind that the tick of a watch is louder after winding, while it is fainter after cleaning and oiling. A stop-watch is the best, as with it we may at any moment stop the ticking, and in this way we are able to check the veracity of the patient. This precaution is specially necessary in the examination of children. As watches differ very much in pitch and intensity of tone, the particular watch used for the purpose should be tried on a number of persons having good hearing. The distance in inches, at which the tick is heard by a person of good hearing power, is termed the normal hearing distance, and forms the standard in testing the hearing power of patients. Thus, if the normal hearing distance of a given watch is 36 inches, and the actual hearing distance of a patient is 20, this fact would be expressed by the fraction $\frac{20}{36}$. This is a very convenient and simple way of expressing, in the record of a case, the state of the hearing power. If the tick is not heard even when the watch is pressed on the ear, we express the condition of hearing as $\frac{0}{36}$; if heard on pressure, as $\frac{p}{36}$; while, if the watch is heard on slight contact, as $\frac{c}{36}$. To ensure accuracy we must use a measuring rule, which must not be touched by the watch, while we are testing the hearing. We should first hold the watch close to the best ear, so that the patient may know the character of the sound, and thus be able to distinguish it from other sounds, especially from subjective ones. The ear which is not being tested should then be carefully closed, and the watch held, parallel with the auricle, beyond the hearing limit, and then brought gradually nearer to the ear until we find the exact hearing distance. The eyes should be shut or covered, especially in children, so that the watch may not be seen by the patient. *Politzer's Acumeter or Hörmesser* (Fig. 21) consists of a pillar of vulcanite (*a*) rather more than an inch in length, into which are fitted an immovable cylinder of steel (*c*), about an inch in length, and a short distance above this a movable lever about an inch and a half in length, with a longer arm terminating in a small ball (*b*), so as to form a percussion hammer, and a shorter arm (*e*), pressure on which raises the hammer. The vulcanite pillar is held between the index finger and the thumb, and, the shorter arm of the lever being pressed down by the middle finger, the longer arm with the percussion hammer is raised to a fixed height, and, being allowed to fall on the steel cylinder, a sharp click is produced. As the height of fall and the dimensions of the instrument are the same in all cases, the amount of sound is uniform. In the vulcanite pillar, above the percussion hammer, is a perforation for the insertion, when required, of a metal pin, four centimetres in length, having the free extremity terminating in a round metal plate (*d*). This pin

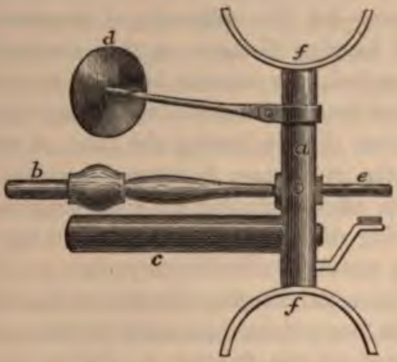

FIG. 21.—Politzer's Hörmesser.

is intended to be used when testing the perception of sound conveyed through the bones of the head by pressing the metal plate on the temporal bone or mastoid process. The advantages claimed by Politzer for this, as compared with the watch, are—1st, The uniformity of the sound produced. The normal hearing distance of this standard measurer being determined, the number is made the denominator, and the actual hearing distance of the patient the numerator of the fraction, thus indicating the ratio of the power of hearing in the given case to normal hearing. With the greatest care, after excluding all disturbing elements, the normal hearing distance for this instrument has been found to be fifteen metres, about sixteen yards; and, if in a case before us the actual hearing distance as measured by the Hörmesser be four metres, the condition of the patient would be represented by the fraction $\frac{4}{15}$, and so on. 2nd, By making pauses in the production of the sound we can convince ourselves of the accuracy of the statements of the patient as to his perception of the "click." The continuous ticking of the watch renders this difficult both to practitioner and patient. 3rd, The intensity of the click of the Hörmesser, being so much greater than the ticking of any watch, makes it possible to determine the degree of sharpness of hearing in many cases, where the tick of the watch cannot be perceived. 4th, In consequence of this greater intensity of tone in the Hörmesser, the results determined by it can be better compared and contrasted with those obtained by the whispered voice than in the case of the watch; and, therefore, when the hearing distance as shown by the Hörmesser increases, we can conclude with a greater degree of certainty that the hearing distance for the voice is also increased. Having seen the practical application of this instrument in Professor Politzer's clinique in Vienna, and having since had personal experience of its value, the writer is able to confirm all that the inventor has said regarding its advantages, and confidently to recommend it as a valuable diagnostic instrument. Unfortunately, however, its value as a standard of comparison in different cases has recently been somewhat impaired, owing to slight variations in the size of the instrument as supplied by different makers, and consequent variations in the "click."

The original maker carried out Professor Politzer's instructions and measurements so carefully, that the instruments were practically uniform, and the results of examinations by various observers could be expressed in terms of a standard.

(*b*) SPEECH.

We should never confine ourselves to the mode of testing the hearing by simple tones, but should also ascertain as far as possible the patient's capacity for hearing speech.

This is specially important in children, whose statements as to the hearing of the tick of a watch are often unreliable. There is frequently a striking want of agreement between the hearing capacity for the watch or Hörmesser and that for speech. A patient may not hear the watch on pressure, and yet may hear lightly-spoken words at a considerable distance, or, on the other hand, the watch may be heard $\frac{20}{40}$, but speech not understood farther off than a yard. Sometimes, in a patient with both ears affected, the hearing of conversation is better on the side where the hearing of the watch is worse.

In the treatment of deafness we occasionally find this disparity very marked. In the course of treatment the hearing of speech may distinctly improve, while the hearing distance for the tick of a watch may remain unchanged, or even, as has been observed, actually become less.

Persons, who have become deaf in later life, usually hear speech better in proportion than the watch, while the opposite holds good with those who have become deaf in childhood.

In testing the hearing by means of speech, the ear should be turned towards the examiner, while the opposite ear should be carefully stopped with the moistened finger of the patient, and the eyes of the patient should be shielded or turned away, so as not to see the face of the speaker. It is well known that deaf persons often acquire great aptitude in reading the lips, and in guessing the meaning of what they do not hear from the sense of what they do hear. They are often surprised at the degree of their deafness, when tested, while their eyes are closed or turned away from the speaker. This accounts for the fact that deaf persons often appear to hear worse at the time of dusk, when sight cannot give such effective aid; and hence also they understand bearded and moustached men much worse, from the greater difficulty of seeing the movements of the lips, than persons with smooth faces. Women have a special aptitude for lip-reading.

A whisper is more suitable for testing the hearing than loud speaking, not only because we can maintain a greater uniformity at different and distant times, but also because in one-sided deafness the whispered voice is not so likely to be heard through the good ear, or through the bones of the head, and, further, in whispered speech the disparity between the sound of vowels and that of consonants is less marked. If the deafness is very great, however, the loud-spoken voice must be used.

Vowel sounds, it is well known, are heard much more clearly and loudly than consonants. Oscar Wolf, of Frankfurt-on-Maine, has investigated very thoroughly the acoustic characters of the different elements of speech. His investigations show the relative distance at which the vowel and consonant sounds can be distinguished when loudly sounded.

If the vowels and consonants are pronounced as in German, and the distances expressed in paces, the highest and richest in tone is *a* (*ah*), which was heard at a distance of 360 paces; while the lowest and feeblest is *h* aspirate, heard only at 12 paces. Between these extreme limits Wolf found $o = 350$, *ei* and $ai = 340$, $e = 330$, $i = 300$, $eu = 290$, $au = 285$, $u = 280$, $sch = 200$, $s = 175$, *g* and *ch* soft $= 130$, *ch* rough and uvular $r = 90$, *f* and $v = 67$, *k* and hard $g = 63$, *t* and $d = 63$, *r* lingual $= 41$, *b* and $p = 18$.

To avoid guessing by the patient, it is well to pronounce single words and not sentences, the patient repeating them word for word after the examiner. In normal hearing a whispered word should be heard, if we exclude all other sounds, at a distance of about 25 yards. We should not repeat the same words on different days. Familiar words are heard by deaf persons at a greater distance than words which are not well known; and hence the distance, at which words of a foreign tongue are heard, is sometimes only $\frac{1}{3}$th or $\frac{1}{8}$th that of the mother tongue (Politzer). When testing a young child, in whom complete deafness is suspected, we may employ the sound of a bell, a sharp whistle, or a very loud tone of voice, taking care that the child does not see the source of the sound. It is usual for deaf patients to hear high tones best, such as a woman's or a child's voice; but occasionally we meet with persons who hear deep tones best.

In most deaf persons absolute silence and stillness of the surroundings favour the hearing of spoken words or other sounds; but it has been long known that in certain forms of ear disease the patient hears *better in a noise.* This peculiarity is termed *Paracusis Willisii*, because Willis, in 1680, first described a case, in which a husband could be heard by his deaf wife only while the servant was beating a drum. Not unfrequently deaf patients tell us that they hear much better when travelling in a railway carriage, or while in the presence of noisy machinery, than in complete stillness. Some writers try to explain such an apparent paradox by pointing out that in a railway carriage the confined space, the nearness to the speaker, the elevation of the voice, and the close attention of the listener may account for the apparently better hearing. This matter has, however, been put beyond dispute by the observation of Politzer and others, that the tick of a watch or the click of the Hörmesser is actually heard by some deaf persons farther away from the ear in a railway carriage than in a quiet room. There are two explanations given of this peculiarity:—1st, That by von Tröltsch, who supposes that in such cases there is a slight separation of the incus from the stapes, and that the strong sonorous vibrations press the membrane farther inwards, and thus restore the continuity in the ossicular chain; and, 2nd, That by Politzer, who believes that the improved hearing in a noise is the result of the severe shaking of the ossicles, when their joints have become stiffened by a catarrhal process. In this way the small bones are made fitter for the transmission of sound.

The detection of simulated or exaggerated deafness is often difficult, particularly if *total* deafness is simulated. In continental countries, where compulsory military service exists, this form of malingering is much more common than in this country. To make the deception more easy, foreign bodies are pressed into the ear, or caustic substances applied to the canal. An objective examination should in the first place be carried out. When the person does not feign *total* deafness, the hearing power should be accurately tested and noted while he is blindfolded, and comparisons made at intervals, when the great disparity in the apparent hearing, as stated by the patient, who does not see how far he hears, reveals the true state of matters. When there is feigned *total* deafness, it is more difficult to expose well-planned deception. Such expedients as observing if loud speech awakes the individual out of sleep, if opprobrious statements made in his presence have any effect on his features, or the effect of informing him "to go, as he is unfit for work," &c., may be tried. When we have to ascertain if total unilateral deafness exists, it is a good plan to cause the supposed malingerer to apply to his ears a double-tube stethoscope, having the tube for his hearing ear plugged. When the cup-shaped end of the stethoscope is spoken into, the person will probably say he hears. If the tube is now removed from the hearing ear, and the latter closed with the finger, he will say that he no longer hears, knowing as he does that the hearing ear is shut, while the tube of the stethoscope is only in the ear, with which he pretends to be deaf.

V.—GENERAL PLAN FOR THE EXAMINATION OF A PATIENT.

In the examination of a patient, who suffers from an affection of the ear, we should follow a regular plan. After the preliminary questions as to name, age, occupation, and residence have been answered, we should inquire (*a*) into the past history of the case, and (*b*) into the present condition of the patient.

(*a*) The History of the Case.

It is often difficult and tedious to elicit from the patient a clear and correct account of the mode of beginning, and of the course of the disease. If the case be one simply of defective hearing, his statements as to the duration of the deafness are often very unreliable. He may at first say six months, then, on being more minutely questioned, admit that his hearing has not been very good for years. If it is a case of discharge from the ear, or if the disease has arisen suddenly with acute symptoms, the patient's statements as to the time of its origin are more trustworthy. In our investigation into the etiology of the disease we should keep in view such possible causes as the exanthematous diseases, depraved constitutional states, as the scrofulous, the syphilitic or the tubercular cachexiæ, hereditary influences, nasopharyngeal catarrhs, cold water bathing, &c. Ascertain if the deafness, noises in the ear, discharge from the ear, or other symptoms have been fluctuating, rapidly or slowly getting worse, or stationary. The past state of the general health must also be determined. Finally, ascertain if treatment has been at any time used, and, if so, the nature of it.

(*b*) THE PRESENT CONDITION OF THE PATIENT.

1. *Subjective Symptoms.*—The degree of impairment of hearing must be carefully tested by the watch or the Acumeter and speech. We must test not only the ear complained of, but also the presumably normal one, which is often found to be also defective in hearing. The osseous conduction of sound must be tested in the manner already described. If subjective sounds in the ear (tinnitus aurium) are complained of, inquire as to their intensity, character, variability, and relation to the deafness. Pain in the ear, giddiness, or headache are frequently complained of by aural patients, and should be subjects of inquiry. Ask also about the sensation of the patient for his own voice, whether muffled, confined, loud, or quite inaudible.

2. *Objective Examination.*—In disease of any organ of the body this part of the investigation is of very great importance, but it is specially so in diseases of the ear. The subjective symptoms may be extremely marked, and yet objective examination may reveal nothing more than a simple furunculus, or a collection of cerumen in the canal of

the ear. On the other hand, the most serious structural changes may have taken place in the tympanic cavity without any complaint other than that of more or less deafness. We should examine, *first*, those parts which may be seen with the unaided vision. The auricle, outer part of the external auditory canal, the mastoid region, and the neighbouring parts may be examined in this way. The outer orifice of the ear may be partially or wholly occupied by purulent or other secretions, or it may be closed by diffuse or furuncular inflammation of its walls, or a polypoid growth may be seen protruding from it. The skin over the mastoid process may be red, and the soft tissues underneath infiltrated and swollen, while slight pressure may cause the most acute pain. With such a condition of the mastoid process, the auricle usually stands out strikingly from the side of the head. Again, we may find over the mastoid process one or more openings, covered with soft granulation tissue, communicating with either a carious aperture or a sequestrum in the cortical part of the mastoid process. Or there may be a cicatrix adhering to the bone, marking the situation where such an opening previously existed. The glands over the mastoid process and those in the neck are frequently enlarged, especially when purulent disease of the ear exists. In children who are partially deaf the facial expression is sometimes characteristic, having an emotionless or even silly aspect, mainly due to the habit of inattention engendered by the difficulty of hearing, and a habitually open mouth, consequent upon chronic obstruction of the nasal passages.

Secondly, we must employ the speculum and reflecting mirror in order to examine the whole of the external auditory canal and the tympanic membrane. The condition of the walls and the contents of the external canal must be noted, such as its curvature and width, the colour of its lining, the injection of its vessels, the possible existence of fistular openings, the quantity and character of the cerumen, the presence of purulent or mucous secretion or sodden epidermis, polypi, hyperostosis or exostosis, inflammatory thickening or swelling of the cutaneous lining, furunculi, necrosed bone. We should inspect with great care the condition of the tympanic membrane and, if a part of that membrane is destroyed, the interior of the tympanum. If the membrane is entire, the following points require our attention:—Are the colour, polish, and transparency of the membrane normal? Is there a general redness, or are the vessels individually injected, especially in the membrana flaccida and along the manubrium? Is the colour in whole or in part yellowish or yellowish green, indicating the presence of secretion in the tympanum? Are there opacities, local or general, or calcareous deposits? Is there a cicatrix—a dark, sharply defined, depressed part of the membrane—indicating a past perforation? What is the form and extent of the cone of light? Is the membrane, in whole or in part, bulged outwards from the effects of exudation in the tympanum or in the interstices of the membrane? Or, on the contrary, is the membrane depressed, sunken, with the manubrium drawn in and shortened, with increased prominence of the short process and anterior and posterior folds? Are the incus, stapes, and promontory more distinctly seen than in the normal condition, owing to a sunken or atrophied membrane? Is the manubrium clearly seen, and is it thinner and smaller than it ought to be? Are there small, shining prominences in the membrana flaccida, and is this area of the ordinary size? By means of Siegle's speculum ascertain if there is normal mobility of the membrane, if there are atrophied parts or cicatrices, which are shown by their extreme mobility with suction; or if there are, on the contrary, adhesions between the membrane and the wall of the tympanic cavity. When, as in the greater number of purulent diseases of the ear, a part of the membrane is destroyed, we must determine the size, shape, and situation of the perforation, as well as the condition of the mucous membrane of the exposed tympanum. Is the mucous membrane pale and dry—swollen, thickened, congested and secreting—the seat of granulations or polypoid growths? Is any part of the incus or stapes exposed by the perforation? Does the part of the membrane which remains adhere to any part of the tympanic walls or contents, or is it congested, infiltrated, or thickened, or is it the seat of calcareous deposition? What is the condition of the manubrium? Is it shortened or even quite invisible, or is it complete but partially divested of its membranous attachment, or is it adherent to the inner wall of the tympanum? It may be here observed that even in extreme cases of loss of the membrane, there usually still remains a narrow rim at the circumference, as well as a part of the membrana flaccida.

We examine, next, the nasal passages and pharyngeal cavity, as described at p. 64.

Lastly, the Eustachian tube and tympanum are to be examined by the effects produced, when a stream of air is forced into the tube by any of the various methods already described. It is well to test the hearing immediately after this inflation has been performed, in order to determine the effects, if any, upon the power of hearing.

It may be useful as a guide to the student in recording cases of ear disease to append the following scheme, which is suitable for both hospital and private practice.

Scheme in Use in the Western Infirmary, Glasgow, for recording the Cases of Ear Disease (reduced to a third of the real size).

Diagnosis—R.
L.
No. Date
Name Age Occupation Residence
History of Affection

Tinnitus
Discharge
Pain
General Health
Family Tendency to Ear Disease
Giddiness
Headache
Articulation

HEARING DISTANCE.	RIGHT EAR.			LEFT EAR.		
	Before Treatment.	After Air-Bag.	After Catheter.	Before Treatment.	After Air-Bag.	After Catheter.
Watch						
Whispered Voice						
“Hörmesser”						
PERCEPTION BY BONES OF HEAD.						
Tuning-Fork						
Watch						
“Hörmesser”						
Patient’s Own Voice						

OBJECTIVE EXAMINATION.

RIGHT EAR.	LEFT EAR.
Auricle	
Mastoid Process	
Ext : Aud : Canal	
TYMPANIC MEMBRANE	
Cavity of Tympanum	
Eustachian Tube	
Nasal Passages	
Pharynx	

Remarks.

TREATMENT AND COURSE.

DATE.	HEARING DISTANCE.		
	Watch.	Hörmesser.	Whispered Voice.

CHAPTER II.

CAUSES OF EAR DISEASE.

ALTHOUGH in the description of the individual diseases of the ear, their causation will in each case receive attention, it may be useful at this place to review in a general way the various predisposing and exciting causes, which are apt to give rise to morbid conditions of the organ.

I.—Heredity.

Hereditary tendency is a strong factor in the causation of almost all forms of ear disease, but more especially of those morbid changes which are usually designated chronic adhesive catarrh of the middle ear. The congenital malformations of the inner ear, frequently found in connection with deaf-mutism, are also, no doubt, the effects of hereditary tendencies. We sometimes find the hereditary disposition extremely marked, where almost every member of a family has some form of disease of the ear. It is to be noted, however, that the offspring may not be affected with the same disease as the parent. For example, the father may have chronic adhesive catarrh of the middle ear, while his children may be liable to purulent inflammation of the middle ear. We may find also that the hereditary tendency is not direct, that, while the father and grandfather have enjoyed a healthy state of the organ, the uncle or grand-uncle may have had ear disease. Politzer believes that the hereditary influence is stronger in the second generation than in the immediate offspring. It must be remembered, however, that these diseases are very common, and that, although we shall frequently discover by diligent inquiry that some relative has dulness of hearing or an ear-discharge, we would not be justified in all such cases in concluding that real hereditary tendency exists. It is asserted by some that the hereditary tendency consists in a peculiar formation of certain parts of the middle ear, such as a peculiarly narrow or small formation of the recesses leading to the fenestral membranes, favouring the detention and organization of catarrhal products. Probably the hereditary peculiarity is rather what may be called the "catarrhal tendency," which almost always manifests itself at the same time in a special liability to nasal and pharyngeal catarrhs.

II.—Age.

The peculiarities attending different ages of life are important factors in the production of ear disease. In childhood there is a marked liability to exudative diseases of the middle ear, especially of a purulent character, as compared with persons of more advanced years. While this frequency is to a great extent due to the prevalence of exanthematous diseases at that time of life, it is also connected with certain peculiarities of structure existing in childhood. These are the small size of the naso-pharyngeal space, the thickness of the mucous membrane of the Eustachian tube, and the narrowness of the pharyngeal mouth of the tube. The frequency of adenoid vegetations in childhood also favours, to a material extent, the production of ear disease. The rapid formation of mucous membrane in the tympanic cavity, which takes place soon after birth, probably favours congestive processes in the tympanum, and it has been shown that purulent collections are frequently found to exist in the middle ears of young infants. In middle and advanced life, on the other hand, the chronic adhesive or dry catarrh of the middle ear is very much more frequent than in children. In old age the flaccid soft walls of the cartilaginous Eustachian tube, as well as the feeble state of the tube muscles, may probably cause disease by disturbing the ventilation of the middle ear.

III.—Position in Life, Habits, &c.

Position in life, occupation, habits, and surroundings have great influence in the causation and continuance of ear disease. In the case of the poor, their greater exposure to all kinds of weather; their cold, damp, ill-ventilated dwellings; their deficient nourishment and scanty clothing, render them more liable to inflammatory affections of the ear, which in such persons are also likely to be more persistent. We note especially the effects of these evil influences in the children of the poor suffering from chronic purulent inflammation of the middle ear. Workmen exposed to loud or sudden noises, such as boilermakers, riveters, or railway engine drivers, are particularly liable to labyrinthine mischief, from undue irritation of the auditory nerve. Those, again, who have to work in the midst of air loaded with dust or dirt, or who are employed in an office where the air is confined, close, and impure, are prone to ear affections. All these circumstances are especially injurious, if a predisposition, hereditary or otherwise, exists in the individual. The immoderate use of alcohol and of tobacco may not only directly produce ear disease where the tendency to such exists; but, by bringing on a state of chronic catarrh of the pharyngeal mucous membrane, ear disease may be in that way indirectly caused.

IV.—*General Diseases, or Morbid Changes involving the Circulation.*

The strumous, the tubercular, and the syphilitic cachexiæ not only powerfully predispose to disease of the ear, but they also engraft upon these diseases a specially unfavourable tendency. In the strumous constitution acute inflammation of the middle ear is very apt to take a suppurative form, and to become chronic, persistent, and attended by serious complication. While this is true, we have to protest against attributing, as is done by some practitioners, all chronic purulent discharges from the ear to the strumous diathesis. This view is often taken by practitioners as an excuse or reason for neglecting local treatment, and advising general remedies, with which they are more familiar, but which are usually by themselves quite ineffective. Again, mucous catarrh of the middle ear is much more obstinate in the strumous child; while dry adhesive processes in the middle ear, when they do affect children, which is rare as compared with their frequency in the adult, usually occur in those of strumous constitutions.

In tubercular patients purulent forms of ear disease are not only common, but they are usually, in such patients, attended by destructive softening of the tympanic membrane. In both scrofulous and tubercular persons chronic adhesive catarrh of the middle ear is more apt to take an unfavourable course than in those of healthy constitution.

Syphilis may affect the organ of hearing in several ways. Condylomata, or ulceration in the cutaneous lining of the ear, may be due to it; or, in the stage of secondary symptoms, mucous catarrh of the middle ear may be excited by simple extension of the throat affection to the middle ear. A form of chronic catarrh of the middle ear, with rapid and serious loss of hearing, involving the labyrinth, is met with. Labyrinthine disease, coming on gradually or suddenly, leading to total loss of hearing on one or both sides, and associated with keratitis or iritis, is not unfrequently met with in children suffering from hereditary syphilis.

We shall refer presently to the influence upon the organ of hearing, through mere continuity of skin and mucous membrane, of the exanthematous diseases, especially of scarlet fever and measles; but these diseases may also cause important changes in the ear, especially in the labyrinth, through the circulation, causing serious and permanent defect of hearing. The other zymotic diseases not unfrequently induce mischief in the ear. During typhus or typhoid fever temporary deafness and tinnitus are often observed, and are probably in most cases due to hyperæmia of the labyrinth, but permanent changes in the ear may also originate in these affections. The aural disturbance sometimes found in those who have suffered from intermittent fever is probably due rather to the effects of quinine than to the disease itself.

Bright's disease, acute or chronic rheumatism, gout, anæmia, marasmus, &c., are each not unfrequently associated with ear disease, but the exact nature of the causative relation is not clear. An attack of mumps is sometimes attended by permanent and total deafness in one or in both ears, from some, as yet unknown, change in the labyrinth. Hysteria, pregnancy, and the period of lactation are not unfrequently associated with disturbance of the hearing, or with aggravation in ear disease which has previously existed. Deafness is also sometimes observed during puerperal fever.

Organic disease of the heart, lungs, or large vessels, by causing stasis of the venous circulation in the head, or by producing undue arterial tension, may lead to hyperæmia of the mucous membrane of the nose, throat and ear, passing, it may be, into distinct tissue changes.

Certain medicinal substances, especially quinine, salicine, opium, and alcohol, when taken into the circulation, may induce disturbance in the organ of hearing, especially hyperæmia of the inner ear, producing deafness or some form of tinnitus. They have a more injurious effect, if disease already exists in the ear, when even small doses may distinctly aggravate the aural symptoms.

V.—Disease in Parts Adjoining the Ear.

There is probably no more important predisposing or exciting cause in producing or maintaining ear disease than the presence of disease in the neighbouring parts, especially in the nasal and pharyngeal mucous membrane. On account of the great importance of the subject, a special chapter is devoted in this work to the relation of diseases of the ear to the nasal and pharyngeal mucous membrane, to which the student is referred. Suffice it to say here that there are no more frequent causes of middle ear disease than those which attack the organ by the pharyngeal entrance to the ear. Not only do acute and chronic catarrhs of the naso-pharynx and adenoid vegetations excite catarrhal or inflammatory processes in the middle ear, but pneumonia, bronchitis, influenza, hooping-cough, &c., may excite morbid conditions of the middle ear, either by simple continuity of the mucous membrane, or by the strong expiratory efforts in coughing, condensing unduly the air in the middle ear. Further, the exanthematous diseases, especially scarlet fever and measles, with both of which ear disease is so frequently associated, usually invade the ear from the nose and throat through the mucous membrane of the pharyngeal mouth of the Eustachian tube. Any one of the diseases of the middle ear may have its origin in scarlet fever and measles, but the purulent inflammations of the middle ear arise thus more frequently than the simple catarrhs. Probably the most obstinate purulent diseases of the ear, and those which are attended by most destruction of the tympanic membrane, arise out of scarlet fever. Diphtheria may affect the ear by extending up the Eustachian tube from the pharynx; and, when it occurs in conjunction with scarlet fever, the most serious of all purulent diseases may be set up. Diphtheria may also damage the ear by causing paralysis of the muscles of the palate and Eustachian tube.

Disease may also affect the ear through the continuity of the interior of the ear with the cutaneous lining of the body. For example, the exanthemata sometimes affect the ear through the medium of the cutaneous lining of the external auditory canal. Erythema, erysipelas, or eczema, when affecting the head, frequently extends to the auricle and external auditory canal.

Morbid intra-cranial conditions may injuriously affect the auditory nerve or labyrinth. The internal auditory artery may be narrowed or closed from some cause, leading to anæmia of the labyrinth, or there may be aneurism of this vessel. Atheroma in the vessels of the brain is likely to be associated with the same condition of the vessels of the labyrinth, leading, it may be, to hæmorrhage into the latter. Obstruction to the discharge of the venous blood from the labyrinth into the sinuses of the brain may lead to passive congestion. Apoplectic clots, inflammation of the brain or meninges, tumours, abscesses, &c., may damage the root, stem, or expansion of the auditory nerve. Through the aqueduct of the vestibule or cochlea diseased changes in the arachnoid space are in some cases propagated to the interior of the labyrinth.

VI.—Pre-existing Disease in the Ear.

The previous or present existence of disease in the ear may predispose to a return of the same or to other diseases. As in almost all catarrhal diseases, one attack is apt to establish a tendency to future attacks. Thus, a person, who has had at any time catarrhal or inflammatory disease of the middle ear, is more liable to have this again. So the existence of a chronic disease of the ear, such as chronic adhesive catarrh, or chronic purulent inflammation, exposes the individual to acute catarrhal or inflammatory attacks. Then disease in one part of the ear frequently leads to disease in another part. Congestive or inflammatory conditions of the middle ear are often attended by hyperæmia of the labyrinth, leading, it may be, to tissue changes. Chronic catarrhal or suppurative diseases of the middle ear are often followed in time by pathological changes in the labyrinth. Affections of the mastoid process are, in the great majority of cases, the result of pre-existing disease in the tympanic cavity. Again, furunculi, diffuse inflammation, or even hyperostosis of the external auditory canal, may arise from the irritating action of pus or other secretions upon the skin of the canal. Eczema of the auricle is also apt to excite a similar state of the canal, with thickening of the cutaneous lining.

VII.—Neglect of Treatment.

We have to add neglect of proper treatment as an important element in the causation and perpetuation of certain diseases of the ear. From this cause acute diseases frequently lapse into chronic conditions. Thus mucous catarrh, or acute non-perforative inflammation, may pass into the much less curable chronic adhesive catarrh. Probably, however, the disease, which is most frequently due to neglect of treatment, is chronic purulent inflammation of the middle ear, owing to the fact that no efficient efforts are made to cleanse the interior of the ear, where, from the anatomical peculiarities of the part, there exists such a tendency to retention of secretion.

VIII.—Reflex Causes.

Morbid impressions are sometimes transmitted to the ear in a reflex way through the vaso-motor nerves, from various parts of the body.* The effect of cold feet in exciting inflammatory affections of the middle ear is an example of this form of reflex influence. But probably the most marked instance is the production of catarrhal or inflammatory affections by the process of teething in the child, or by caries of the teeth in the adult. The connection of the dental nerves with the middle and external ear, through the Otic and Meckel's ganglia, is probably the path by which the irritation is transmitted from the teeth to the ear. Sympathetic hyperæmia of the ear probably also arises from reflex sympathy with the digestive organs and, in the female, with the procreative organs.

IX.—The Action of Cold.

We do not here refer to the action of cold in producing, primarily, catarrh of the nasal and pharyngeal spaces, and, secondarily, catarrh or inflammation of the middle ear, which is fully considered in the special section, but to the action of cold impressions directly upon the ear. A very large number of ear diseases are set up by this cause. The ear is remarkably intolerant of cold, which may act upon it in various ways, such as by the rushing of cold water into the ear while the person is diving; or by the trickling of drops of cold water into the ear during washing, a shower bath, or the application of ice to the head; or by exposure to cold wind, especially if accompanied by rain, sleet, or snow. In any of these ways cold is a frequent exciting cause of catarrh or inflammation of the ear. Exposure to these causes is especially liable to excite an ear affection, if a marked predisposition to such exists in the individual, or if a chronic disease is already present.

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* Dr. Woakes traces out this connection in his work, "Deafness, Giddiness, and Noises in the Head," London, 1882.

X.—Injuries.

A very considerable number of ear diseases originate in injuries inflicted upon the ear. These may be caused by mischievous interference, by accident, by efforts at treatment, or by loud noises.

Excess of ear wax, furunculi, and acute diffuse inflammation of the external auditory canal are not unfrequently the results of irritating the skin of the canal by efforts to relieve itchiness or remove ear wax. The point of a pen, a tooth-pick, a knitting or hair-pin, a small twig, &c., are used for such purposes, and irritate the delicate cutaneous lining. It occasionally happens that the person's elbow receives a sudden push, which thrusts the hard pointed object inwards, penetrating the tympanic membrane. Efforts to clean the interior of the ear by the use of so-called "aurilaves," or with the corner of a towel, not unfrequently lead to accumulation of the ear wax in the deep parts of the canal. Needless and unskilful syringing of the ear, and the pouring into the ear of irritating or even caustic liquids are sometimes responsible for acute inflammation of the canal, the tympanic membrane, or the middle ear. Even the indiscriminate pouring of bland oil into the ear may prove injurious, owing to its becoming rancid after being in the warm ear for a few days, when it may act as an irritant, or favour the formation of fungi. Boring the lobule of the ear, and the irritation caused by ear ornaments may give rise to disease, especially to eczema, hypertrophy, or cleft lobule. Blows upon the ear, or striking the surface of water with the side of the head, as in diving, may, by the sudden and great compression of air in the external auditory canal, rupture the tympanic membrane, or even some of the tympanic structures, giving rise, it may be, to acute purulent inflammation of the middle ear. If the auricle has been previously weakened by disease, a severe blow may be followed by hæmatoma auris. Violent blows or falls upon the head may fracture some part of the osseous walls of the ear and rupture the tympanic membrane and other soft parts, causing effusion of blood into the middle ear or labyrinth, and perhaps injury to the auditory or facial nerves, followed usually by purulent inflammation of the middle ear. A foreign body in the external auditory canal, especially when it becomes firmly impacted, may cause perforation of the membrane and purulent inflammation of the middle ear. The same results are likely to follow the entrance of boiling water, molten metal, caustic substances, &c., into the ear.

Efforts at treatment, especially when of an injudicious character, may produce serious mischief in the ear. Improper attempts to remove a foreign body, or violent and unnecessary syringing, may bring about acute inflammation of the canal and tympanic membrane. Certain methods of treatment, which are usually safe and beneficial, occasionally prove mischievous. Paracentesis of the tympanic membrane, perfectly safe in the vast majority of cases, occasionally excites acute purulent inflammation of the middle ear. The nasal douche is also in some cases responsible for setting up the same disease. The abuse of the various methods of inflating the middle ear, especially Valsalva's method, may injure the tympanic structures. Rupture of the tympanic membrane is probably never caused by inflation of the middle ear, unless the membrane has been weakened by disease.

Very loud noises, especially if sudden and unexpected, as when a cannon is fired close to the ear, or the piercing shriek of a railway whistle is suddenly heard, not unfrequently originate disease of the ear, and the former may even rupture the tympanic membrane. Constant and loud noises have also frequently an injurious effect on the ears, and hence it is found that a large proportion of men, who are exposed from the nature of their work to such noises, ultimately become deaf.

It has to be observed, lastly, that in some cases no cause can be found to account for the existence of the disease; this holds true especially with regard to chronic adhesive catarrh of the middle ear.

CHAPTER III.

AFFECTIONS OF THE NOSE AND THROAT IN THEIR CONNECTION WITH DISEASE OF THE EAR.

THE mucous membrane lining the nasal passages and pharynx is not only frequently the place of origin of ear diseases, but its morbid conditions have an important influence on the course and issue of affections of the middle ear. In our modes of examination and in therapeutic measures, therefore, attention to this region must be looked upon as of consequence.

I.—MODES OF EXAMINATION.

(*a*) *The Examination of the Nasal Passages and the Naso-Pharynx from the Front—Anterior Rhinoscopy.*

We require a concave reflector with headband, the same as that used in the examination of the ear, and a proper speculum. A large-sized aural speculum (Gruber's) may sometimes suffice to dilate the nostrils. A bivalve speculum (Fig. 22) is, however, more suitable. It is introduced easily when closed, and by pressure upon the handles the leaves are separated and the yielding walls of the nasal entrance dilated. In this way, if good light is reflected into the nasal passage, we may in favourable cases see its whole length. Zaufal

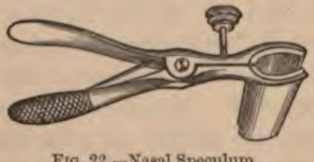

FIG. 22.—Nasal Speculum.

has invented a tubular speculum ten centimetres long and seven millimetres wide, which is introduced like a Eustachian catheter through the inferior meatus of the nose, as far as the upper pharyngeal cavity. When the nasal passage is of sufficient width to allow of the introduction of such a tube, we may see, with good reflected light, the movements of the soft palate and of the lips of the mouth of the Eustachian tube during phonation or swallowing. Cresswell Baber, of Brighton, has devised a self-retaining nasal speculum* for dilating the anterior nares, made of two wire hooks united by an elastic band, provided with a buckle, for passing and

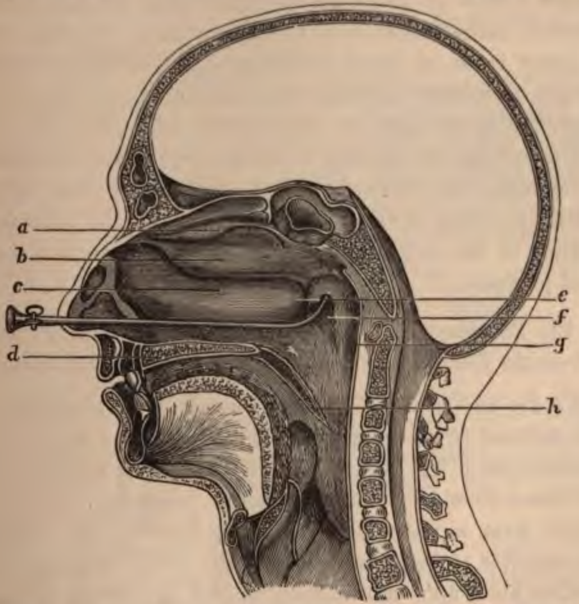

Fig. 23.—Section showing the Outer Wall of Nasal Passage and Pharynx (after Politzer). For explanation of figure see p. 10.

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* Made by C. Wright & Co., 108 New Bond Street, London.

securing round the patient's head. This contrivance is very convenient, when both hands are required for operation.

As seen by anterior rhinoscopy, the mucous membrane of the nasal passages has usually a bright red colour. The inferior and middle spongy bones are seen projecting from the outer wall. In many cases the bulging of the septum of the nose to the one side or a very prominent spongy bone limits our view to the anterior parts. Between the inferior spongy bone and the floor of the nasal passages we see the inferior meatus of the nose, through which the catheter is passed in catheterization of the Eustachian tube (Fig. 23). In some cases of great swelling or hypertrophy of the mucous membrane covering the inferior spongy bone, the inferior meatus may be quite filled up. Between the middle and inferior spongy bones we see the middle meatus of the nose. In extreme cases of catarrhal swelling of the mucous covering of the middle spongy bone, the pendulous swelling of the mucous membrane may be mistaken for a nasal polypus.

(*b*) *The Examination of the Nasal Passages and Naso-Pharynx from the Lower Pharyngeal Cavity—Posterior Rhinoscopy.*

We are indebted chiefly to Czermak and Semeleder for this method of examining the nasal pharynx, which is a modification of laryngoscopy. The mirror introduced into the throat should be smaller than in laryngoscopy, and it should form a right angle with the handle. The tongue also requires to be pressed down with a bent spatula, while a palate hook may be necessary to pull the uvula upwards and forwards out of the way. Bright illumination is essential, and the direct rays of the sun reflected from a flat mirror form an admirable source of light. While the mirror is in the pharynx, the patient's head should be inclined slightly forwards, and he should breathe slowly through the nose. The space between the soft palate and the posterior wall of the pharynx is increased when the patient pronounces a nasal syllable, as the French "en."

This mode of examination is often difficult and sometimes impracticable. The difficulty due to contraction of the pharyngeal muscles may generally be overcome by rapidity and delicacy in the use of the throat mirror; but when, as we find in some persons, the posterior edge of the soft palate is close to the posterior wall of the pharynx, posterior rhinoscopy may be impossible.

In favourable cases the image seen in the mirror (Fig. 24), when its reflecting surface is directed upwards and forwards, includes the posterior edge of the nasal septum in the centre, though generally deviating somewhat to one side, and the posterior ends of the three spongy bones projecting from the outer walls of the nasal passages. The superior spongy bone is the smallest, appearing as a small ledge-shaped projection at the uppermost part of the posterior nares. The middle one is usually the largest and most distinct, and forms an oblong protuberance of a grayish colour. The inferior turbinated bone is usually only seen in its upper part, and appears in the mirror as a grayish rounded projection not reaching so near to the septum of the nose as the middle spongy bone. The inferior spongy bone may, when its mucous membrane is very

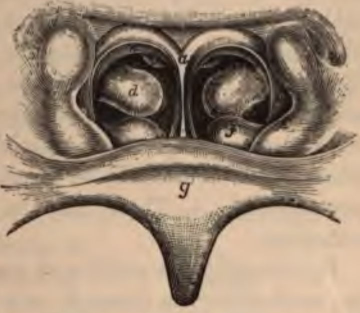

FIG. 24.—Parts seen by Posterior Rhinoscopy (Urbantschitsch):—*a*, upper part of posterior edge of nasal septum; *b*, superior spongy bone; *c*, choanæ; *d*, middle spongy bone; *e*, pharyngeal mouth of Eustachian tube; *f*, inferior spongy bone; *g*, soft palate.

much swollen, encroach upon the pharyngeal mouth of the Eustachian tube.

If the reflecting surface of the mirror be now directed somewhat laterally, we may see the pharyngeal mouth of the Eustachian tube. This is found a little behind the inferior spongy bone somewhat above the upper surface of the soft palate (Fig. 23). It has generally a triangular form, the base being directed forwards and the apex backwards, and has usually a whitish colour. Between the posterior bulging lip of the mouth of the tube and the posterior wall of the pharynx is seen the hollow known by the name of the fossa of Rosenmüller. In diseases of the middle ear we find various forms of pathological changes in the mucous membrane lining the pharyngeal mouth of the Eustachian tube. 1. It may be much congested, swollen, and covered by catarrhal secretion. 2. It may be studded with granular projections, especially when there is granular pharyngitis. 3. It may be covered by the so-called adenoid vegetations. 4. There may be ulceration, cicatrices, or adhesions.

By changing the position of the mirror so that the reflecting surface may be directed as nearly as possible upwards, the image of the roof of the pharynx and a part of the posterior wall of the upper pharynx is seen in the mirror. In many cases of ear disease, especially in children, the thick glandular tissue embedded in the mucous membrane of these parts, and known as the pharyngeal tonsil, is seen to be much hypertrophied and the seat of outgrowths, the so-called adenoid vegetations, which may in some cases fill the upper pharyngeal cavity.

(c) *Digital Examination of the Upper Pharyngeal Cavity.*

This mode of examination often yields valuable information, and should be employed especially when posterior rhinoscopy is impracticable. The patient should be seated, and, while we steady his head with the left hand, the right index finger (the first phalanx of which should be protected with a piece of India-rubber tubing) is introduced as far as to the posterior wall of the pharynx. The tip of the finger is then passed up behind the uvula, taking care not to push the uvula before it. The muscular spasm which takes place usually passes off, when the point of the finger is fairly in the upper pharyngeal cavity. During the examination the patient should take full and regular inspirations through the nose. By moving the finger in the proper directions we can, in most persons, gain a pretty clear notion of the condition of the upper surface of the soft palate, of the posterior edge of the nasal septum, of the posterior end of the inferior spongy bone, of the mouth of the Eustachian tube, of Rosenmüller's fossa, and of the vault of the pharynx.

(*d*) *Examination of the Lower Pharyngeal Cavity.*

The walls of this cavity are easily examined through the open mouth either by means of reflected light from a mirror on the forehead, or by means of artificial or daylight arranged so that the light shall pass directly into the open mouth. In most persons it is necessary to press the tongue downwards upon the floor of the mouth. The flat handle of a spoon is often sufficient for this purpose, but a tongue depressor is frequently used. A convenient form consists of a double spatula (Fig. 25) made of vulcanite, the two pieces of which are connected together by a hinge joint. In some persons the attempt to

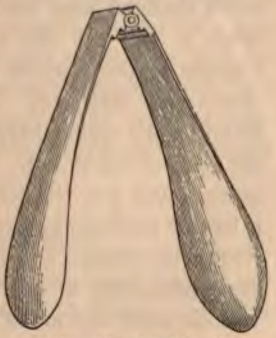

FIG. 25.—Spatula for depressing the tongue.

depress the tongue sets up spasmodic contraction of the muscles of the pharynx and troublesome retching. In these cases the use of the finger to depress the tongue may be better tolerated; or we may be able, without attempting to depress the tongue, to get a view of the pharynx, while the person takes a full inspiration. The examination is generally facilitated by the patient breathing deeply through the mouth or pronouncing the letter A (ah), during which the soft palate is raised.

In addition to the posterior part of the upper surface of the tongue we see the movable curtain of the soft palate, the uvula, the posterior wall of the pharynx or mucous membrane covering the pre-vertebral structures, and on each side the anterior and posterior pillar of the fauces with the tonsil in the niche between them. When the tongue is well depressed, especially in children, the upper part of the epiglottis is sometimes visible.

As the result of catarrhal or inflammatory processes, the condition of the various parts of the pharynx may be very much changed from the normal. In their relation to diseases of the ear the chronic catarrhal or inflammatory changes of the various parts of the lower pharynx most deserve our attention. It is a mistake to judge of the condition of the *upper* pharyngeal space from the appearance of the back of the throat. The latter may appear almost quite normal, and yet the former may be involved in very considerable morbid changes. The lining membrane is not unfrequently swollen or thickened, of a bluish red colour, and very intolerant of touch, and the divisions between the various parts are much less marked. The uvula is often elongated and œdematous at its tip, or, on the other hand, it may be extremely short and puckered. It is sometimes broad and sometimes thin and pointed. The soft palate has frequently a thick, red appearance. The uvula may deviate to the one side, especially during contraction of the palate muscles, with a smooth inactive state of the soft palate on the side from which the uvula deviates. The tonsils are very commonly enlarged, especially in childhood, when they may almost meet in the middle line. On the other hand they may be so atrophied as to have almost disappeared. We may find numbers of red or reddish-grey elevations on the posterior wall of the pharynx due to swollen or hypertrophied follicles—the so-called follicular or granular pharyngitis. The intervening mucous membrane may be pale and thin or slightly red and swollen. Sometimes we see an elongated, reddish, spongy-looking elevation on each side passing up from the posterior pillars of the fauces towards the mouths of the Eustachian tubes. At other times we find the mucous membrane smooth, thin, red, and glazed, either dry (probably from atrophy of the follicular glands), or covered with greenish, laminated masses of secretion, evidently, in part at least, coming down from above. Connected with this state there may be great anæsthesia of the mucous membrane, so that free touching with the mirror is tolerated without any muscular response. Lastly, in the atrophic stage of chronic catarrh we find the mucous membrane whitish and so extremely thinned, that the constrictor muscles lying in front of the vertebræ may be seen shining through. In this condition varicose veins may traverse the mucous membrane.

II.—MORBID CONDITIONS.

The chief morbid conditions of the nasal and pharyngeal mucous membrane, which exercise an influence upon the middle ear, are—

(*a*) **Acute Catarrh.**
(*b*) **Chronic Catarrh.**
(*c*) **Adenoid Vegetations.**

These conditions influence the middle ear through the medium of the Eustachian tube in the following ways. 1st, By extension of the congestion, swelling, and hypersecretion to the mucous lining of the cartilaginous part of the Eustachian tube, thus interfering with its ventilating function. 2nd, By further extension of this process to the mucous lining of the tympanum and perhaps also to the mastoid cells, causing in the slight forms the catarrhs of the middle ear, and in the more severe forms simple or purulent inflammations of the middle ear. 3rd, By swollen, thickened, or hypertrophied tissue or adenoid growths encroaching upon the pharyngeal mouth of the tube, and thus bringing about mechanical closure. Enlarged tonsils pressing the soft palate upwards upon the tube and adenoid vegetations overlapping the mouth of the tube are examples of this. 4th, The thickened or hypertrophied mucous membrane of the soft palate may interfere with the contraction of the tensor palati and levator palati muscles. The fibres of the tensor palati and the levator palati are very intimately connected with the mucous membrane covering them. The thickened mucous membrane (in the soft palate it may be three or four times thicker than natural) will impede muscular contraction, and bring about a disproportion between the resistance and the moving power. This impairs the muscular mechanism by which the walls of the membrano-cartilaginous part of the tube are in turn separated and approximated. 5th, Through interference with the nasal breathing, depriving the ear of a proper supply of pure air. 6th, By the effects of obstruction in the nasal passages causing undue rarefaction or condensation of the air in the middle ear. When the nasal passages are markedly obstructed, rarefaction of the air in the upper pharyngeal cavity is produced by every act of swallowing, just as in Toynbee's experiment. This naturally leads to rarefaction of the air in the tympanic cavity through the aerial medium of the Eustachian tube. On the other hand, under the influence of vehement expiratory acts, as coughing, blowing the nose, sneezing, &c., the air, unable to find its way through the nasal passages, may pass through the Eustachian tube with damaging effect upon the middle ear through the sudden abnormal condensation of the air in the tympanum. 7th, Probably certain forms of tinnitus aurium are due to the irritation caused by the pressure of the thickened mucous membrane upon the nerves, especially upon the branches of the trigeminus, affecting sympathetically the auditory nerve.

(a) Acute Catarrh of the Nasal and Pharyngeal Mucous Membrane.

Symptoms.—There are here hyperæmia, swelling, and hypersecretion, the morbid process frequently extending to the sinuses and canals communicating with the nasal passages. The secretion is at first thin and serous, afterwards becoming thicker and more viscid. There is a sense of "stuffing" or obstructed breathing through the nose, also attacks of sneezing, with occasionally frontal headache and tenderness over the superior maxilla. The tone of the voice becomes changed, the nasal voice being in abeyance. When the pharyngeal mouth of the tube is involved in the swelling and hypersecretion, there is a sense of fulness and ringing in the ear with some impairment of hearing. Giddiness is sometimes complained of, probably due to sympathetic relation through the trigeminus.

Under favourable circumstances the symptoms usually pass off in from a few days to two weeks. In certain states of the constitution, however, such as the strumous diathesis, or if a markedly catarrhal tendency exists in the individual, the acute catarrh may pass into the chronic form, which may continue with varying degrees of intensity for years or even during a lifetime.

Treatment.—When there is a tendency to frequent attacks of acute catarrh, especially if these are accompanied by any disturbance in the ear, careful preventive measures should be used. These include the avoidance of sudden and extreme changes of temperature, of damp cold air, of exposing the uncovered head to the cold open air, of indulgence in alcohol, or excessive smoking. The growth of a moustache has sometimes a good prophylactic effect. Cold or tepid salt water sponging of the body, followed by brisk friction; plenty of fresh open air during mild and dry weather; residence in the country, especially in a mountainous region or in a wooded district; these tend to invigorate the general health, and have been held to lessen the liability to attacks of catarrh.

Local treatment during the actual attack relieves the unpleasant symptoms in the nasal passages and head. The inhalation through the nose of the vapour of hot water, or of hot water with the addition of some stimulating substance, as vinegar, spirit of camphor, carbolic acid (f. 80, 81, 82), or the application to the interior of the nose of a bland substance, as vaseline, has a useful and pleasant effect. When there is great dryness, giving a sense of stuffing, the inhalation of chloride of ammonium in the nascent state is beneficial (f. 85). Inhalation of the fumes of solid iodine is useful; small portions of the iodine are placed in a quill with cotton above and below, and, while it is partially volatilized by the heat of the hand, the fumes are sniffed into each of the nostrils. Inhalation of the fumes of Hagar's anti-catarrhal mixture (f. 84) is also held in great estimation by some as "abortive" treatment for acute coryza. The solution of chloride of ammonium, or bicarbonate of soda, used as spray

(f. 46, 47), relieves the sensations in the nose. If great pain over the frontal sinus is experienced, a small local abstraction of blood by means of two or three leeches is attended with relief. A single application of the solution of the muriate of morphia (f. 87), in the form of spray, to the nasal passages, often relieves the sense of discomfort, and may even cut short the catarrhal process. Diaphoretics, such as Dover's powder or the vapour or hot air bath, are efficient means of shortening the attack. A large dose of opium, or of carbonate of ammonia, or of alcohol, is sometimes used within twenty-four hours in order to abort an attack. Confinement to the house in a warm but well ventilated room also facilitates the disappearance of the symptoms.

(*b*) Chronic Catarrh of the Nasal and Pharyngeal Mucous Membrane.

Pathology.—In chronic catarrh we have, in addition to dilated vessels and parenchymatous serous infiltration, round cells in the mucous membrane and submucous tissue changing in time into connective tissue. The glandular tissue embedded in the mucous membrane always participates in the chronic inflammatory process, especially in the roof of the pharynx and in the lower part of the posterior wall, constituting granular or follicular pharyngitis. Small cysts filled with a colloid fluid often form in Rosenmüller's fossa in connection with the catarrhal process. After a time the contents of the cysts escape and the walls coalesce, leaving behind a number of fine fibres bridging the fossa. The mucous membrane covering the inferior spongy bone may be swollen to such an extent as to touch the septum and fill up the inferior meatus, while behind it may bulge into the upper pharyngeal cavity, and even cover the mouth of the Eustachian tube. The mucous membrane over the middle and superior spongy bones may become very much hypertrophied, forming flap-shaped masses, which may be readily mistaken for polypi. The red hypertrophied mucous membrane is distinguished from genuine polypi by the gray oyster-looking appearance of the latter, which are also readily moved and displaced by a probe. Nasal polypi frequently form in connection with chronic catarrh of the nasal mucous membrane, and their presence tends to keep up the condition of chronic catarrh. Polypi having their origin in the nasal passages sometimes project into the upper pharyngeal cavity, and may even be seen in the throat below the posterior edge of the soft palate.

The catarrhal process may lead to atrophy of the mucous membrane. Over the posterior wall of the lower pharynx the membrane is then seen to be thin, smooth, whitish, and often dry and glazed; while in the nasal passages the spongy bones become very small, so as to be sometimes scarcely perceptible, and the space between the septum and the outer wall becomes so widened that we may with good light and an ordinary nasal speculum see distinctly the posterior wall of the upper pharyngeal cavity, and the action of the palate muscles in swallowing. This condition is frequently met with in ozæna. It has been asserted that the fœtor characteristic of ozæna is due to this wide condition of the nasal passages. The expired air, it is said, meeting with less resistance from the walls of the passage, has not the same effect of sweeping before it the secretions of the nose, which, as a consequence, lie stagnant and decompose.

Ulcerative processes in the mucous membrane and disease of the osseous walls are met with most commonly in syphilitic affections, and, less frequently, in persons of strumous constitution. Portions of necrosed bone from the septum, spongy bones, or floor of the nasal passage may, in these conditions, come away. As a result of syphilitic ulceration we not unfrequently find whitish, thick, and tough radiating cicatrices in the pharynx, and sometimes the Eustachian tubes are closed by the cicatricial tissue, and even the cartilaginous part may be destroyed by the specific ulceration.

Symptoms.—The quantity and character of the secretion in chronic catarrh present great varieties. It is often very scanty, especially when the disease is retro-nasal in situation, and the sensation is more that of dry obstruction in the nose, or that of a stuffed head. At other times there is a feeling in the throat as of something requiring to be brought up, impelling the person to make great and noisy efforts to bring up phlegm from the throat. These efforts are probably successful in expelling small pellets of tough and adhesive mucus, which, if the person resides in a city, have usually a dark colour. This inclination to "hawk" is usually most felt in the morning. After swallowing hot liquid the mucus loosens, and is brought up more easily. At other times greenish masses of secretion are brought up, having their source in the upper pharyngeal cavity. In some persons, especially those who habitually indulge too freely in alcoholic stimulants, these "hawking" efforts excite, particularly in the morning after rising from bed, a spasmodic action of the pharyngeal muscles, causing retching and even vomiting. Sometimes the quantity of secretion from the nasal passages is very great, purulent in character, and, it may be, with a very offensive smell. In the form of chronic catarrh, which has received the distinctive name of ozæna, the secretions have an extremely offensive odour, which is sometimes sufficient to banish the person from all society. The patient is seldom conscious, unless informed by others, of these offensive exhalations. In ozæna we may find dried greenish crusts, or even membranous portions adhering so closely to the mucous membrane as to render it difficult to wash them completely away.

Bloody sputa, which may resemble pneumonic expectoration, sometimes occur in chronic catarrh of the pharyngeal cavity. The blood comes from the congested vessels, and, when such sputa are brought up, and no pulmonary cause is found to exist, the upper pharynx should be carefully examined. It is to be remembered that chronic catarrh may be localized, and limited to the retro-nasal cavity. After using the Eustachian catheter we sometimes find on the catheter greenish-gray masses, which have evidently come from the upper pharyngeal cavity.

The partial or complete obstruction of the nasal passages, or of the upper pharyngeal space, attending the swelling, thickening, or hypertrophy of the mucous membrane, interferes with due *nasal breathing*, and the breathing may become in great part or altogether *oral*. This peculiarity may continue as a habit long after the actual obstruction has passed away. The change produced in the physiognomy of a child by its being constrained to breathe habitually through the open mouth is often very characteristic, and at once suggests the condition of the nasal passages and pharynx. The mouth is open, the nose is pinched-looking, and the nostrils fallen in, while the expression of the countenance is foolish, vacant, and dull. If defective hearing also exists, the manner is inattentive. The voice is also changed in character and in strength from the want of resonance in the nasal passages. It is weak in the higher tones, and the pronunciation of *m* and *n* sounds like *b* or *d*. For example, the word "common" is pronounced like "cobbod."

The evil effects of obstruction of the nasal passages upon the organ of hearing have been already pointed out. But other evil effects may result from defective nasal breathing. 1st, Impairment or loss of the sense of smell. While this is often due to the changes produced by the catarrhal process upon the terminal structures of the olfactory nerve, there is no doubt that, when the function of the nerve is in abeyance for a long time through the absence of nasal breathing, there may result permanent injury to the sense of smell. 2nd, In addition to local changes in the larynx, trachea, and lungs, the general health may suffer. The walls of the nasal passages present extensive, warm, and moist surfaces, which form a kind of natural respirator, warming, moistening, and purifying the inspired air, before it passes over the vocal apparatus and into the lungs. The dust and other irritating particles in the air are partly detained on the irregular and projecting surfaces of the spongy bones. Hence nasal breathing is favourable to a healthy condition of the vocal and respiratory organs. When a child regularly inspires into its lungs over a period of years air, which by passing through the mouth is colder, drier, and more impure than it should be, we might expect an injurious influence upon the lungs and general health. We find by experience that the health of a child in such a condition is often manifestly improved after the nasal passages have been treated for some time.

In the sucking infant catarrhal obstruction of the nasal passages may have a serious effect on the health and comfort of the child. An infant breathes, of course, chiefly and most comfortably through the nose, hence such an obstruction would render the act of sucking difficult, or even impossible. This refusal to take the breast, from impeded nasal breathing, is probably sometimes confounded with some other and more important ailment. The great discomfort arising from the difficult nasal breathing also prevents sleep, and the child passes restless nights. It is clear that if these two great essentials to infant life—sucking and sleeping—

are interfered with, injury to the health must soon ensue.

Persons who breathe habitually by the mouth during sleep, usually have a dry mouth in the morning, and they do not feel comfortable, until they gargle the throat or eat a warm breakfast. Pain is not unfrequently complained of in the frontal and maxillary sinuses, probably owing to extension of the inflammatory process to these cavities. Pain, evidently of a reflex character, may be experienced in other parts of the head, especially in the occipital region, but also in the side of the head. These pains, generally called neuralgia or megrim, are probably due to pressure exerted by the thickened tissue upon the numerous nerve fibrils of the trigeminus ramifying in the mucous membrane, and affecting by sympathy adjoining branches of the same nerve trunk.

The tendency to hay-fever is thought by some to be due to an abnormal condition of the mucous lining of the nasal passages; while asthmatic attacks are believed to have occasionally their origin in a reflex effect, excited by a chronic swelling or thickening of this membrane.

We would also here suggest the possible injury to the general health sustained by the constant inhalation of the gases of decomposition in ozæna. The question might also be raised as to the injurious effects exercised upon the digestive organs by the decomposing pus swallowed by patients suffering from that disease.

We have lastly to point out that in chronic nasal catarrh slight eczematous conditions sometimes arise just inside the nostrils. Crusts may in this way form which plug up the nostrils, and in infants lead to serious obstruction to nasal breathing, or the irritation may give rise to erythema in the neighbouring skin, and sometimes even to erysipelas.

Treatment.—It is convenient to describe the treatment of chronic catarrh of the nasal and pharyngeal mucous membrane under two heads. 1st, The treatment of the nasal passages and upper pharyngeal cavity; and, 2nd, The treatment of the lower pharyngeal cavity or throat.

1st, *In the treatment of the nasal passages and upper pharyngeal cavity*, two objects must be held in view:—(*a*) To remove the secretion and disinfect the parts; (*b*) To check the hypersecretion and remove the chronic hyperæmic swelling and thickening.

(*a*) A careful and long-continued use of cleansing and disinfecting appliances is sometimes sufficient to cure or mitigate the chronic catarrh. In the removal of the secretion simple water is not so suitable as a fluid of greater specific gravity. I have found the following cleansing and disinfecting solutions very useful:—1. Two drachms of common table salt to a pint of water, or, if the mucus is very viscid, one drachm of common salt and one drachm of bicarbonate of soda to a pint of water. 2. A solution of chlorate of potash, borax, and carbolic acid (f. 55). 3. A weak solution of carbolic acid, or permanganate of potash (f. 50, 51). 4. The solution of the chlorinated soda in a diluted form (f. 56). The last four formulæ are especially suitable for ozæna. It is to be noted that all solutions used as nasal applications should be tepid.

These cleansing solutions may be employed in several ways.

(1.) *By simple sniffing.*—A small quantity is put into the hollow of the hand or in a tablespoon or saucer, and with moderate inspirations drawn through the nasal passages into the pharynx and then expelled by the mouth. A teacupful may be used in this way at one sitting. This may be repeated nightly. As a popular remedy the sniffing of cold water through the nose is often used as a means of strengthening the mucous membrane against a tendency to catarrh. Some persons attain great perfection in this mode of applying fluids to the nasal passages, while in others it produces headache or excites a fresh cold.

(2.) *By Weber's Nasal Douche.*—This consists of a jug or vessel, capable of containing at least a pint of fluid, and an India-rubber tube furnished with a nose-piece. The other end of the tube is fixed to a perforated peg at the bottom of the vessel, or is simply placed at the bottom of the fluid in the vessel. In the former case a catch is affixed near to the nasal end of the tube to regulate the flow of fluid; in the latter case the tube, before being used, must be exhausted of air. The vessel should be placed two or three feet above the level of the patient's head. By reflex action, while the liquid passes in through the nasal passage, the soft palate rises and accurately closes the communication with the lower pharynx, so that the liquid flows round and passes out of the opposite nostril, carrying with it mucus or other secretion. On account of the hydrostatic pressure exerted on all sides of the nasal passages and pharynx, the fluid may force its way into the Eustachian tubes or into the frontal sinus, exciting severe frontal headache. There is no doubt that in some instances acute inflammation of the middle ear has in this way been caused by the use of the nasal douche. Roosa and Knapp of America record such cases, while the author has observed at least one instance of purulent inflammation of the middle ear resulting from the use of the nasal douche. In order to guard against this possible danger the following precautions should be borne in mind. 1st, The vessel containing the fluid should not be situated too high, and the stream should be occasionally interrupted. 2nd, The patient must not swallow during its use, and he should breathe through the open mouth. 3rd, The head should be bent slightly forwards. 4th, A *strong* medicated solution must not be used. 5th, If one of the nasal passages is narrower than the other, the stream should be directed into the *narrower* one. 6th, If one nasal passage is quite impermeable, or if the Eustachian tube is abnormally open, the nasal douche should not be used at all.

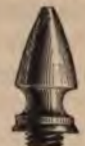
FIG. 26.—Nasal Piece for Syringe.

(3.) *By the Syringe.*—We may inject the fluid either directly into the anterior nares, or into the upper pharyngeal cavity. A vulcanite syringe, furnished with a conical nasal piece (Fig. 26), and capable of containing two ounces of fluid, is suitable for use by the anterior nares. The stream of fluid should be directed straight backwards, in order to avoid the frontal sinus, and the nasal piece must not be inserted too tightly into the nostril. The crusts or scabs formed of inspissated secretion frequently found in the nasal passages, especially in ozæna, are more thoroughly removed by the syringe than by the nasal douche. In the use of the syringe most of the precautions mentioned in connection with the nasal douche should be kept in mind. When we wish to inject fluid directly into the upper pharyngeal cavity, we may use—1st, the posterior nasal syringe, which is furnished with a long tube (Fig. 27) terminating in a perforated extremity, and curved in such a way that we are able, after passing it through the mouth, to turn the point upwards behind and above the soft palate. This is an excellent mode of cleansing the walls of the upper pharyngeal cavity and washing away tough secretion, and it is attended by less danger than the use of the anterior nasal syringe; or, 2nd, we may wash out the upper pharyngeal

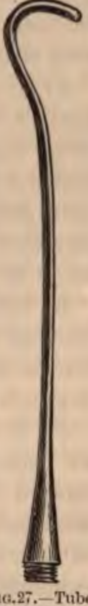
FIG. 27.—Tube attached to Syringe (Fig. 51) for syringing by the Posterior Nares.

cavity very thoroughly by injecting fluid through a silver tube of the length and diameter of a medium-sized Eustachian catheter, but closed at the inner end and without the curve, the sides of the inner end of the tube having a number of perforations. The tube being introduced through the inferior meatus of the nose, until the perforated part is in the upper pharyngeal cavity, the liquid is forced into the outer opening of the tube by means of a syringe or the siphon tube of the nasal douche, and in this way a number of small jets issuing from the small perforations are directed against the walls of the upper pharyngeal cavity. If the purulent secretion is very considerable in quantity, these local ablutions should be employed twice daily.

As an aid in the removal of secretion an air-bag may be used to force air into one of the nostrils. The nasal piece of the bag is fixed air-tight into the nostril, while the other nostril is open. Secretion may not only be expelled from the nasal passages but also from the neighbouring cavities, the maxillary or frontal antrum. A sense of relief is often experienced by the patient after this method has been employed.

In infants or young children with eczematous crusts blocking up the nostrils, the free application of vaseline or benzoated ointment may be required repeatedly before thorough cleansing is secured.

(*b*) In addition to cleansing and disinfecting applications we generally require, in order to check the secretion and remove the catarrhal swelling, to act upon the mucous membrane by various astringent, absorbent, and caustic substances. A great variety of medicated solutions is employed. Any one of the following solutions may be used alternately until we find the one most suitable for the particular case. 1st, Four grains of tannin to an ounce of water—the effects are sometimes increased by adding a grain of salicylic acid. 2nd, A solution of sulphate of zinc, beginning with two grains to the ounce of water and then gradually but cautiously increasing the strength. 3rd, A solution of four grains of powdered alum to an ounce of water. 4th, Equal parts of salicylate of soda, bicarbonate of soda, and chlorate of potash, as much as will cover the point of a knife to an ounce of water, to which a drop of oil of turpentine may be added. Any of these solutions may be employed in quantities of about an ounce at a time.

The solutions may be applied to the nasal and pharyngeal mucous membrane by any of the methods already described, but preferably with the syringe anteriorly or posteriorly. The posterior nares syringe or the anterior with the long tube are excellent methods of applying a medicament to the upper pharyngeal cavity. For the use of patients at home Politzer's plan is a good one. He pours the fluid out of a glass vessel such as an ordinary medicine measure, into one of the nostrils, while the head is inclined backwards. When the fluid passes into the upper pharynx the head is bent quickly forwards, so as to allow the solution to flow out of the opposite nasal passage. By this method the solution is brought into contact with the walls of the upper pharyngeal cavity, including the mouths of the Eustachian tubes.

A very convenient and useful mode of applying solutions to the interior of the nasal passages and pharyngeal cavity is in the form of atomized or spray *inhalations*. A Richardson's spray apparatus, with an acorn-shaped point, suitable for introduction into the nostrils, is required. Von Tröltsch has introduced a modified form in which the tube is so lengthened, that we are able to pass it through the inferior meatus of the nose into the upper pharyngeal cavity, and so direct the spray to the vicinity of the mouths of the Eustachian tubes. Any of the solutions already mentioned

(f. 59 to 64) may be employed in the form of spray and by the patient himself at home.

The inhalation of *vapour* is of value especially during acute exacerbations of the chronic state. An India-rubber nasal-piece placed on the mouth-piece of an inhaler is required for the effective use of nasal inhalations. Inhalations of simple vapour of water are useful in softening hardened secretion, or when a dry condition of the mucous membrane exists. The inhalation of the fumes of chloride of ammonium, when that salt is exposed to great heat, or the inhalation of its vapour in a nascent state by means of Lewin's apparatus or Burrough's inhaler, is often of great service in removing congestive swelling of the nasal and pharyngeal mucous membrane. Vapours of iodine, camphor, carbolic acid, creasote, benzoin, &c., are used frequently with advantage After steam inhalations, exposure to the outer air should be avoided for an hour or two. For the various forms of inhalations which may be employed see f. 79 to 86.

Ointments are at times very serviceable applications. In eczematous conditions inside the nostrils, especially in children, the frequent use of formula No. 19 is very beneficial after the crusts have been washed away. Vaseline and iodoform (f. 26) are also useful in healing slight abrasions or ulcerations in the interior of the nasal passages.

Probably there is no application so effective in removing chronic swelling and hypersecretion of the mucous membrane as a solution of *nitrate of silver* (40 grains to the ounce). If, after a fair trial has been made of the preceding solutions twice daily, over a period of two or three weeks, no distinct advantage si apparent, we should then in addition employ the solution of nitrate of silver, which must be applied by the surgeon himself. After thorough cleansing of the nasal passages and upper pharyngeal cavity, the nostril is dilated by Baber's dilator, and by means of cotton on a cotton-holder, similar to the one used for the ear, the solution is applied to all the accessible mucous membrane, so as to whiten the parts. Afterwards the patient should plug the nostril for a minute or two with cotton soaked in a weak solution of salt. We are generally able in this way to apply the caustic solution to the greater part of the mucous lining of the nasal passages. When we wish to apply it to the upper pharyngeal cavity, the cotton-holder should be longer, and curved behind the soft palate, or a curved brush may be used similar to that in Fig. 28. In these ways we can apply the solution freely to the roof, back, and lateral walls of the cavity. By the aid of rhinoscopy, in suitable cases, we may apply the solution to particular parts, such as the mouths of the Eustachian tubes. A good plan of applying the solution here is by means of a small piece of sponge fixed to the end of a wire introduced through a wide Eustachian catheter, while the latter is *in situ*. There is usually no more irritation produced by the application of a solution of nitrate of silver than a temporary feeling of heat or burning, which, if severe, can be relieved by an injection of a weak solution of salt. When applied to the mouths of the Eustachian tubes there

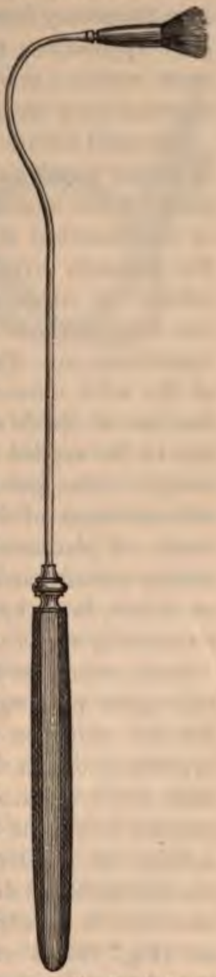

FIG. 28.—Brush for applying liquids to upper pharyngeal cavity.

may be increased deafness and tinnitus for a short time, from temporary increase of the swelling. Sometimes, after a few applications, the mucous membrane is rendered much more healthy; at other times this treatment requires to be repeated every second day for two or three weeks.

The solid nitrate of silver, fused on the point of a sound of proper length and curve, is sometimes applied to limited parts of the mucous membrane, which may be the seats of circumscribed thickening or intense general swelling. For example, hypertrophied mucous membrane over the inferior or middle spongy bone, limited thickenings in the neighbourhood of the Eustachian tubes, and adenoid vegetations are often benefited by repeated applications of the solid nitrate of silver. Posterior rhinoscopy, or the use of Zaufal's tube, is essential, when the caustic has to be applied to any part of the upper pharyngeal cavity. The galvanic cautery, however, is the most efficient means of destroying hypertrophied mucous membrane. A platinum loop or point, rendered red hot by the electric current, and applied several times, at intervals of some days, to the hypertrophied tissue, is effectual, safe, and attended by very little pain (see p. 124).

Medicaments are frequently applied to the nasal passages and upper pharyngeal cavity in the form of *fine powder*. For the reduction of thickened mucous membrane and hypersecretion, finely powdered alum or tannin are the most useful of such applications. Thorough cleansing is essential before the insufflation of any powder. By simple sniffing, the powder may be brought in contact with the anterior parts of the nasal passages. But some form of insufflator is usually required, and that described for the ear (Fig. 29) is very suitable. The thickish substance formed by the mixture of alum with the secretions must always be thoroughly removed before a fresh application of the powder is made. In order to insufflate powder from the throat into the upper pharyngeal cavity, we must use a bent vulcanite tube similar to that employed for the larynx. The wall of the tube has an opening, which, after the powder has been introduced, is closed with the finger or a slide, while the insufflation is performed. Powders may also be applied to the upper pharynx through a wide Eustachian catheter, whose beak is weakly curved. When the catheter is introduced through the nasal passage, its point is directed to that part of the upper pharyngeal cavity requiring the powder, and the powder is then blown out of the tube. When the powder is intended for the mouth of the Eustachian tube, the catheter is introduced through the opposite nasal passage, and its beak moved so as to hook round the posterior edge of the nasal septum. By insufflation the powder is then blown upon the mouth of the opposite Eustachian tube. A straight tube is most suitable when the powder is intended for the posterior wall of the pharynx.

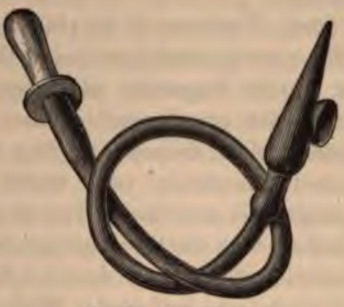

FIG. 29.—Insufflator.

Nasal polypi should be removed with a Wilde's snare of greater length and strength than the one used for aural polypi. A strong loop made of No. 5 piano wire is made to encircle each of the growths, while a Baber's speculum is used, with good light reflected into the nasal passages. As compared with the forceps, this method is attended by much less pain, less bleeding, and less danger of injuring the mucous membrane or spongy bones. If a great tendency exists to recurrence of the polypi, the galvanic cautery should be repeatedly applied to the roots, or to the hypertrophied mucous membrane forming the basis of the polypi.

2nd, *Treatment of the lower pharyngeal cavity or throat.* The mucous membrane lining the lower pharyngeal cavity or throat frequently also requires treatment in connection with ear disease. When it is simply relaxed, soft, and swollen, frequent *gargling* or the use of proper medicated *lozenges* is very useful. The usual method of gargling is very ineffective, as the liquid rarely comes in contact with the throat proper, but remains in front of the anterior pillars of the fauces. The method of von Tröltsch is much to be preferred. While the head is inclined backwards, the liquid is allowed to flow into the back of the throat, when the muscular movements of swallowing are to be performed several times without actually allowing the liquid to be swallowed. This in some persons may be difficult at first; but after a few attempts it can generally be accomplished satisfactorily. In this way not only is the liquid applied more effectively to the throat, but at the same time the pharyngo-tubal muscles are exercised, and a good influence is thereby exerted upon their functional activity in opening the Eustachian tube. The gargle should be used at least night and morning, and in many cases three or four times a day. The ingredients of gargles are very various. Many patients are benefited by simply using a glass of fresh water morning and evening, or a half teaspoonful of common salt dissolved in half a pint of water. Chlorate of potash, borax, tannin, and alum gargles are all employed (f. 70 to 74). While the solution of alum is often very beneficial to the mucous membrane, it is destructive to the dentine.

Suitable sedative and astringent lozenges are given under the formulæ Nos. 75 to 78. This is a very convenient and pleasant mode of applying medicaments to the pharyngeal mucous membrane.

When the congestive swelling or thickening is more pronounced, stronger stimulation is essential, and the applications must be made by means of a brush or cotton on a cotton-holder. The glycerine of tannin, solution of perchloride of iron, solution of sulphate of copper, tincture of iodine, and the solution of nitrate of silver (f. 65 to 69), are probably those from which most benefit is derived. The solution of nitrate of silver, in the strength of thirty grains to an ounce of water, is probably the most effective, used every third day for eight or ten times. The others may be used daily, and they should be continued for several weeks.

In *granular pharyngitis*, or when there is great localized thickening of the mucous membrane, solid nitrate of silver fused on the point of a probe, or a strong solution of perchloride of iron, applied to the individual parts is useful. But I have derived most satisfaction in the treatment of granular pharyngitis from the use of the galvanic cautery and from the application of the "London paste" (f. 4) to the particular hypertrophied parts.

When *hypertrophied tonsils* exist in connection with deafness, they should be removed or diminished in size. By acting like a foreign body in the throat they keep up the catarrhal process. They press up the velum palati and its mucous membrane, partially or completely closing the mouths of the Eustachian tubes, and interfering with the function of the tube muscles. Besides, by obstructing the breathing, they injure the respiratory organs and hinder the proper development of the thorax. Operation is generally to be preferred to cauterization. The tonsillotome is the best form of instrument, and in operating the enlarged tonsil should not be drawn too far out from its niche. Only the part projecting beyond the pillars of the fauces need be removed, as the remainder contracts sufficiently. While substances such as nitrate of silver and iodine have little effect upon hypertrophied tonsils, there is no doubt that repeated use of the galvanic cautery or of "London paste" is followed by marked diminution in the bulk of the enlarged tonsil. The knife or the tonsillotome is, however, the most rapid and the most thorough mode of treatment. An elongated or hypertrophied uvula may be a source of irritation, and may tend to aggravate the catarrhal state. The lower part should be snipped off with uvula scissors, while it is held by forceps.

In chronic catarrh of the nasal and pharyngeal mucous membrane, constitutional treatment is frequently of great advantage. If the scrofulous or syphilitic diathesis exists, appropriate remedies must be prescribed (f. 98 to 107). The digestive functions should also receive atttention.

(c) Adenoid Vegetations in the Roof of the Pharynx.

We are indebted to Meyer of Copenhagen, Guye of Amsterdam and Löwenberg of Paris for their valuable labours and writings in connection with this subject. Meyer first drew the attention of the profession to their importance, and they have since been found to exist with surprising frequency.

Pathology.—Luschka has described a mass of glandular tissue, which he denominated the pharyngeal tonsil, found chiefly in the roof of the naso-pharynx, but which also extends from the roof along the posterior and lateral walls into Rosenmüller's fossa and above the mouths of the Eustachian tubes. The so-called adenoid vegetations consist of an exuberant growth or hypertrophy of this tissue. Microscopically they consist of mucous glands and lymphoid tissue with closed follicles. They appear in the form of either tongue-shaped, cylindrical, or flat excrescences chiefly in the postero-superior walls, the first variety being met with most frequently in the posterior wall or junction of the posterior with the upper wall, while the cylindrical are most common on the lateral walls. They not unfrequently extend to the posterior nares, where they interfere with the due permeability of the nasal passages. The growths are in some cases soft, friable, and easily brought away; in other cases they are firm in texture, and have a strong attachment. The pharyngeal mouths of the Eustachian tubes may be completely veiled by them. In connection with and dependent upon this condition the ear may be variously affected; sometimes we find purulent disease, and sometimes simple catarrh, resulting from or maintained by it. Of 175 cases of adenoid vegetations reported by Meyer, 130 were associated with an ear affection.

Causes.—In regard to their causes, they are probably due to chronic catarrh, and are often hereditary just like the latter condition, several members of one family being sometimes affected with them. Measles, scarlet fever, and colds, probably by exciting catarrh of the upper pharyngeal cavity, may lead to hypertrophy of the glandular tissue. Age seems an important factor in their production, for they are rarely met with in persons over twenty-five years of age. Between three and fifteen years seems to be the period of life in which they are most common. From their infrequency after the age of adolescence it is probable that they tend to disappear spontaneously when adult age is reached. A damp, cold climate is favourable to their production, although they occur in all climates.

Symptoms.—The most striking of the symptoms are due to the obstructed nasal breathing (see p. 78). While the upper pharyngeal cavity is rarely filled with them, they may be so situated as to fill the space between the soft palate and the posterior wall of the pharynx, and thus seriously impede nasal breathing. In marked cases we find that in syringing fluid into the one nostril it cannot be made to flow out of the other nostril from the obstruction existing at the posterior nares. There is usually a copious secretion from the growths, and the neighbouring nasal and pharyngeal mucous membrane is generally in a catarrhal condition. On account of the vascularity of these vegetations a little blood may sometimes escape from the nose, and bloody mucus is occasionally expectorated from the throat. There is frequently granular pharyngitis with somewhat enlarged tonsils.

Diagnosis.—While from such symptoms, especially the defective nasal breathing with deafness, occurring in a child, we might suspect the existence of adenoid vegetations in the upper pharyngeal cavity, a correct diagnosis can be attained only by physical examination, especially by the introduction of the finger through the mouth into the upper pharyngeal cavity (see p. 68). Posterior rhinoscopy, where possible, will furnish exact information, but we must generally rely upon digital examination, and, as Meyer remarks,* the practised finger used gently will, without giving real pain, reveal with sufficient clearness the number, situation, size, shape, consistence, and vascularity of the growths.

Treatment.—Although it is probable that these growths disappear spontaneously when adult age is attained, the injury, which may be produced upon the ears as well as upon the general health by their presence during the period of youth and adolescence, renders their removal an urgent duty. In slight cases the treatment described under the head of chronic catarrh, if continued for a length of time, may sometimes suffice to bring about their disappearance. In the softer and flatter forms the method of scraping them away with an instrument or the finger-nail is a safe and often effectual mode of treatment. Justi employs a small sharp spoon affixed to a ring on the index finger; but I prefer, in dealing with the soft and flat forms of the growths, to scrape them away with the nail of the index finger as recommended chiefly by Dr. Guye, of Amsterdam. This may require to be done several times, and, in addition, the treatment suitable for chronic catarrh of the pharyngeal cavity should be carried out, especially cauterizations and injections.

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* See Transactions of the International Medical Congress held in London, August, 1881, vol. III., p. 278. London, 1881.

For the firm, tough, and crested vegetations, instrumental modes of operation are indispensable. Meyer operates through the nasal passages. He uses a ring knife $\frac{3}{8}$ of an inch in diameter, having one sharp edge, and attached to a steel stem eight inches in length. The ring knife, directed perpendicularly, is introduced through the wider nasal passage, between the septum and the spongy bones. When the knife has reached the upper pharyngeal cavity, if the growth is in the roof it is turned horizontally. The left index finger of the operator is introduced by the mouth into the upper pharynx, and the ring knife is pressed up so as to encircle one of the growths, when the knife is drawn forwards severing the growth. Several growths may be thus removed at a sitting. Cauterization with nitrate of silver is used afterwards as well as cold salt water injections. A polypus snare is also sometimes used, through the nasal passages, for the removal of these growths; while the galvanic cautery introduced through a Zaufal's speculum (see p. 64) is sometimes employed for their destruction. But, when we consider that these growths usually occur in children, operations necessitating the passage of instruments through the nose are often quite impracticable. Few children will tolerate a Eustachian catheter, much less such an instrument as Meyer's ring knife.

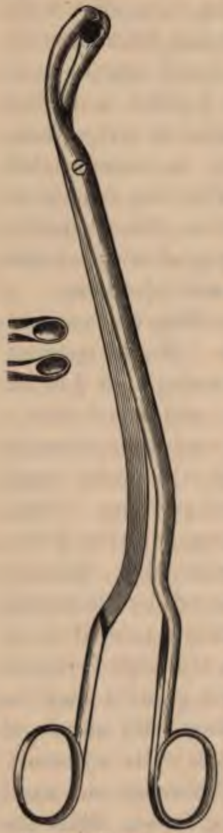

FIG. 30.—Forceps for removing Adenoid Vegetations.

The writer usually operates through the mouth, employing forceps devised by Löwenberg and modified by Dr. Woakes, of London (Fig. 30). After ascertaining by digital examination the position, size, and number of the growths, light is reflected into the pharynx by a concave mirror attached to the forehead in front of the eye. The tongue being depressed with the finger or spatula, the instrument is introduced through the mouth, till the claws are in contact with the posterior wall of the pharynx. If possible, the patient should breathe through the nostrils, when the soft palate moves further away from the posterior wall of the pharynx. The forceps in contact with the posterior wall are pushed up behind the soft palate, when, by separating the claws and pushing them up towards the roof, we shall usually lay hold of one of the adenoid projections and by some traction bring it away. Three or four may in this way be removed at one sitting. By a little patience and coaxing this mode of operating may be practised on very young children. It is desirable to avoid an anæsthetic. There is usually some hæmorrhage from the nostrils, but this, if considerable, can be readily checked by the injection of cold water. After removing the projecting growths with the forceps, the finger nail may be used with advantage to remove the flat and soft remains. If it is possible to practise rhinoscopy, the galvanic cautery will complete more effectually than any other treatment the thorough eradication of the disease. It is probably not essential to continue treatment, until all inequalities are gone, and the mucous membrane has become perfectly smooth. We find by experience that it is sufficient to clear out the upper pharyngeal cavity so as to permit of free nasal breathing, after which the disease rarely returns. When posterior rhinoscopy was practicable, I have also sometimes used nitrate of silver fused on the point of a sound of sufficient length and of a proper curve (Fig. 31). At other times the insufflation of finely powdered alum has seemed to be beneficial in removing the basis of the disease. The treatment described for chronic catarrh of the nasal and pharyngeal mucous membrane should be carried out for a considerable time, especially the saline and alkaline injections through the nasal passages.

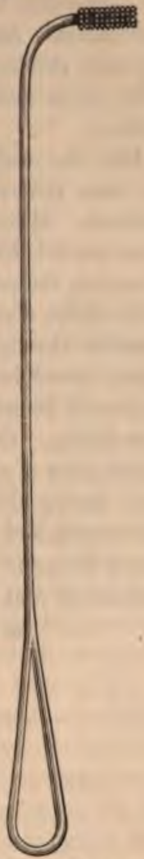

FIG. 31. — Instrument for applying solid Nitrate of Silver to walls of upper pharyngeal cavity (Politzer).

Meyer lays great stress upon after-treatment by repeated cauterization with nitrate of silver in order to prevent recurrence; but recurrence is rare after pretty thorough removal by operation, and the long-continued milder method of treatment already spoken of.

Nitrate of silver is little more than a powerful stimulant, not possessing the property of destroying morbid tissue. The galvanic cautery is an effectual means of doing so, but in young children its application to the upper pharyngeal cavity is in most cases a difficult and often an unsafe proceeding.

After the mechanical impediment to free nasal breathing has been removed, the habit of oral breathing may still continue. Means must be adopted to enable the person to overcome this habit.* The simple plan should be first tried of causing the patient to sit still for fifteen minutes twice or thrice daily, while he studiously keeps his lips closed, and breathes through the nose alone. If after a time this should prove insufficient, the head and lower jaw should be firmly bound at night, so as to keep the lower jaw from falling. Or we may use an India-rubber band with a mouth-piece of soft leather. This band is secured round the head during sleep, so that the leather mouth-piece covers the mouth, and compels nasal breathing. This plan, continued for some time, will frequently cure the bad habit of exclusively oral breathing.

* See Catlin's "Keep Your Mouth Shut."

CHAPTER IV.

METHODS OF TREATMENT.

MANY of the methods of treatment or manipulations employed in diseases of the ear are useful in several affections, and, therefore, for the sake of convenience, and to avoid frequent repetition, we shall consider in this chapter the most important of them.

I.—Inflation of the Middle Ear.

Of all the operative measures practised in diseases of the ear, the forcing of air through the Eustachian tube into the tympanum is probably the one most frequently employed. For a description of the various modes of inflating the middle ear the student is directed to the section on the methods of examining the ear through the Eustachian tube (p. 11).

Its therapeutic value is mainly based upon the mechanical effects of the compressed air on the walls and contents of the middle ear. Its effects on the walls are confined to the yielding parts—namely, the tympanic membrane, the membranous part of the Eustachian tube, the membrane of the fenestra rotunda, and the annular band of the fenestra ovalis.

In many pathological states the tympanic membrane, and with it the ossicular chain, are pushed unduly inwards, so that the base of the stapes presses abnormally upon the fluid of the labyrinth. The vibrating power of the tympanic membrane and ossicula is at the same time impaired by this increased tension. The mechanical effect, produced by the pressure of the air upon the inner surface of the tympanic membrane during inflation, forces out the membrane and chain of bones, thus relieving the labyrinthine fluid, and helping to restore the proper tension. The action of the compressed air in the tympanic cavity will at the same time tend to break asunder adhesions or bands, if these have not become too much organized, and also help to overcome abnormal retraction of the tendon of the tensor tympani muscle. It is possible also that through the mechanical effect of the pressure of air upon the fenestral membranes, if frequently repeated, any tendency to their becoming rigid may be successfully resisted. The stream of compressed air, acting laterally on the Eustachian tube, will co-operate with the tube muscles in separating the outer or membranous wall from the inner or cartilaginous one, and thus open the canal, impermeability of which is generally the result of pathological changes in the mucous membrane, preventing the effective action of the muscles.

The current of air has also an important effect upon fluid secretion in the middle ear. When in the pharyngeal end of the Eustachian tube, the secretion is usually forced by the air into the naso-pharynx. In the tympanic cavity the secretion is finely divided, and scattered in various directions. In this way its absorption by the lymphatics and blood-vessels is assisted, while secretion lying on those parts whose vibrating function is of great importance, such as the ossicular chain or fenestral structures, may be removed to other parts, where its effect on the hearing may be less injurious, such as into the antrum mastoideum, or, if there is a perforation of the membrane, into the external auditory canal.

The Comparative Value of the Various Methods of Inflating *the Middle Ear.—Catheterization* is most useful in the chronic forms of middle ear disease, when a strong somewhat prolonged current of air is required to overcome the resistance offered by adhesions in the Eustachian tube or tympanic cavity. It is also to be preferred, when the disease is limited to one side, and it is undesirable that air should be forced into the normal ear. When liquids, vapours, solid bodies, &c., require to be introduced into the middle ear, the catheter is generally indispensable. In a few rare cases the use of Politzer's method is attended by such unpleasant consequences, that we have to resort to the catheter. Since the introduction of Politzer's method of inflating the middle ear, however, catheterization is much less employed than previously.

Politzer's method possesses certain very important advantages. 1. It is of great value in the treatment of ear diseases in children. Catarrhal affections of the middle ear are, as is well known, extremely common in the early years of life. Before the introduction of Politzer's method, inflation of the middle ear, so important in the treatment of these affections, could only be carried out with the Eustachian catheter, an instrument which few children could tolerate. 2. In acute catarrhal conditions of the nasal and pharyngeal mucous membrane, so often associated with catarrh of the ear, this method has the advantage over the catheter of not irritating the inflamed mucous membrane. 3. When, in the adult, serious difficulties stand in the way of using the catheter, such as extreme nervousness or sensitiveness, peculiar formation of the nasal passages, &c., Politzer's method is a useful substitute. 4. This method requires no such special dexterity as catheterization, and it can not only be carried out by any practitioner, but with proper directions, and under sufficient precautions, it may be employed by the patient himself or by a friend in the intervals between the visits to the surgeon. 5. In certain pathological states of the ear it is found that a better effect is obtained by the sudden gust of air propelled into the middle ear by this method, than by the slower, more gradual current through the Eustachian catheter.

The *Valsalva method* is of most value in cases where the tympanic membrane is perforated. When the membrane is intact, the patient is either quite unable to inflate the middle ear, or, if able, he generally injures the ear by too frequent repetition. Temporary improvement of the hearing not unfrequently attends successful inflation by this method, and hence it is frequently practised by patients and recommended by surgeons. Such efforts repeated by patients, perhaps many times daily, produce on each occasion a congestion of the tympanic vessels, which tends to aggravate the catarrh, for the relief of which they are used. Then, as Politzer remarks, the more frequently it is performed the slighter and shorter in duration is the improvement of hearing—the case usually becoming worse and worse. Strong expiratory efforts produce hyperæmia of the vessels of the head, and stasis of its venous circulation, so that in persons with an unhealthy state of the vessels of the brain, the very frequent and vigorous performance of the Valsalva method is not free from danger to life. Persons have been known to fall unconscious to the ground, when in the act of thus inflating the ear.

As has been said, it is most useful when there is perforation of the membrane. In this case, when there is secretion in the middle ear, the patient is sometimes able to assist very much in the treatment by forcing the secretion from the tympanum into the external auditory canal. In the same class of cases solutions poured into the canal of the ear penetrate more effectually through a perforation into the middle ear immediately after air has been forced by the

Valsalva method through the fluid. It is necessary, when the patient is recommended to try this method, that he be strictly cautioned against its too frequent use; and in elderly persons, especially if liable to giddiness, it should not be employed at all.

II.—Local Abstraction of Blood.

In the treatment of the acute inflammatory affections of the ear local blood-letting is often of very great value. The blood may be removed either by leeches or by scarification with suction. In employing leeches to the ear certain points require our attention. The proper situations for the application of leeches are in front of the tragus, behind the auricle, and over the stylo-mastoid foramen; depletion produces in these places the greatest effects on the ear. When the inflammation has its seat chiefly in the external auditory canal and tympanic membrane, the leeches should be applied over the tragus; when in the tympanum or mastoid cells, they should be applied below and behind the auricle. The deep auricular artery, after supplying the tragus, passes in to supply the deep parts of the external auditory canal and the outer layer of the tympanic membrane, so that in removing blood from the tragus we are more likely to affect the circulation in the canal of the ear and in the tympanic membrane. The soft parts over the mastoid process and behind the lobule have their vascular supply from the stylo-mastoid artery, which provides also the chief arterial supply to the lining membrane of the tympanum and mastoid cells, where also arterial twigs inosculate with the small arteries of the labyrinth. Again, a communication exists between the veins over the mastoid process and the venous sinuses of the dura mater through the diploetic and emissary veins, which pierce the mastoid part of the temporal bone. Hence by abstracting blood from the soft parts over the mastoid process we may exert an influence upon the circulation, not merely of the tympanum and mastoid cells, but also of the labyrinth and dura mater.

In order to avoid any mistake the precise spots, to which the leeches are to be applied, should be marked with ink. If a leech is applied over the parotid gland instead of over the tragus, there is not only great likelihood of irritation and swelling, but the therapeutic effect upon the ear is not likely to be attained. Before using the leeches the external orifice of the ear should be stopped with cotton wool, so as to prevent the entrance of a leech or of blood. After the leeches have come off, the bleeding may be allowed to continue from the bites for ten or fifteen minutes. Instructions should be given as to the proper methods of stopping the bleeding, in case this should prove excessive. If there is a purulent discharge from the ear, the leech bites should be covered with skin plaster or other material so as to protect them from the effects of the irritating pus, which might excite inflammation, ulceration, or erysipelas.

The artificial leech of Heurteloup, which consists of a scarificator and a suction pump, may be used instead of leeches. The scarificator is a small circular knife, which, by pulling a string, is made to revolve rapidly. In this way a circular cut is made in the skin. The pump consists of a glass barrel with a cork piston, the rod of which is a metallic stem wrought into a screw. The suction is made by turning a handle at the outer end of the rod. Before the barrel is applied over the scarified part, the piston should be screwed completely down, while the edge of the barrel, which is to be applied to the skin, should be smeared with grease. By means of this instrument we are able to remove the blood quickly and to regulate the quantity.

III.—Syringing the Ear.

The ear syringe is frequently brought into requisition both in the diagnosis and treatment of diseases of the ear. It must be pointed out, however, that, before the surgeon syringes the ear, he must first ascertain by examination whether ceruminous, purulent, or other accumulations really exist in the ear. Injury is no doubt sometimes inflicted upon the ear by the use of the syringe, when there is nothing to remove. A proper kind of syringe should be employed (Fig. 51). It should not be too large, as by its weight, when filled with fluid, the hand is rendered unsteady. If the surgeon has to deal with ceruminous collections or a foreign body, a syringe which contains four ounces is convenient, but for other purposes a syringe capable of containing two ounces is to be preferred. One made of brass is perhaps to be preferred to vulcanite, as syringes made of the latter substance, although lighter and warmer, are liable to get out of order. It should be furnished with a ledge or other contrivance to prevent slipping of the index and middle fingers when the piston is being pressed down. The nozzle should not exceed an inch and a half in length, should be slender, and should not have a knob-shaped extremity. If the nozzle is too thick, or if it has a bulbous end, the canal of the ear is liable to be stopped up, and the injected fluid, having difficulty in passing out again, may produce dangerous pressure on the deep parts. Ball syringes are sometimes used, but with them it is difficult to avoid mixture of bubbles of air with the water, and so exciting a most unpleasant sound in the patient's ear. The syringe put into the hands of patients should be smaller, as it is generally ordered for cleansing away purulent collections; one which holds an ounce of liquid is large enough. One made of strong glass furnished with a ledge for the fingers is cheap and suitable. Whatever syringe is used by the patient, its nozzle should be provided with a piece of fine, soft, India-rubber tubing, which covers the end of the nozzle and extends about a quarter of an inch beyond its point. This soft tubing may be introduced into the canal of the ear with greater safety by the patient or friend than a hard-pointed instrument. A vessel (Fig. 52) of a suitable size and shape is required to receive the fluid, as it issues from the ear. One made of vulcanite, shaped as in the woodcut, fits the irregular surface under the ear, and, if held close to the skin, will prevent the escaping fluid passing down the patient's neck.

Whatever fluid is employed, the surgeon must be careful that it is *warm*. Cold fluid injected into the ear is intensely disagreeable, and may induce giddiness, or even vomiting. Inflammation of the external auditory canal or the tympanic membrane may result from injecting cold water into the ear.

The point of the nozzle of the syringe or the India-rubber tubing should be placed in contact with the roof of the canal, just within the external orifice. At the same time the auricle should be pulled upwards and backwards with the left hand, so as to remove the curve of the canal. When the object of syringing is to remove pus or other inflammatory products, the syringe should be used gently, and with interruptions, while the stream should be directed rather against the walls of the canal than against the tympanic membrane. A powerful stream of fluid propelled against the softened tympanic tissues may easily do injury; while, if the tympanic membrane is destroyed, such force exerted upon the ossicles or fenestral structures, already weakened by the chronic inflammation, might have even a serious effect.

If the use of the syringe is entrusted to the patient or his friends, as in the treatment of chronic purulent disease of the middle ear, it is essential first to give careful practical instructions. If this is not done it will probably be found that the purulent secretion has not been removed from the deep part of the ear, the cleansing fluid having reached no further than the outer orifice of the canal.

In some persons syringing the ear, even when the membrane is intact, and when done with caution, excites giddiness and, more rarely, nausea and vomiting. These untoward effects are more likely to be caused when the tympanic membrane is perforated, and especially when excessive force has been used. After syringing, the fluid, which is apt to remain in the auditory canal, should be allowed to drain out, after which the passage is to be dried with absorbent cotton, and then a plug of cotton placed in the meatus.

The fluid used in syringing may be simple water, or water medicated with some saline or disinfecting substance. The former is quite suitable for removing accumulations of cerumen. In purulent diseases a weak saline solution is preferable to simple water. Various disinfecting substances are also employed with the water in order to counteract the tendency to decomposition (f. 50 to 53). Organic substances, such as milk, should not be injected into the ear in purulent diseases owing to their tendency to encourage putrefactive processes.

Hinton recommended for certain conditions of purulent disease of the ear the use of a syringe, whose nozzle hermetically closes the external auditory canal. The object was to press liquid through a perforation in the tympanic membrane, and force the secretion contained in the cavity of the tympanum through the Eustachian tube into the pharynx. For the performance of this method of syringing it is essential that the Eustachian tube is freely permeable.

Even although the tube be permeable, this method cannot be regarded as a perfectly safe one, because of the severe pressure to which the walls and contents of the tympanum are exposed. At all events only very moderate force should be employed in endeavouring to press the piston home; and, if this is not sufficient to force the fluid into the pharynx, the method should be abandoned.

The Use of the Small Intra-tympanic Syringe.—In certain cases of purulent disease of the middle ear it is desirable to inject fluid through an orifice in the osseous part of the external auditory canal, or through the opening in the tympanic membrane. For these purposes the middle-ear syringe is employed. I employ a middle-ear syringe similar to one described by Hartmann in the *Deutsche Medicinische Wochenschrift*, No. 44, 1879. This is a vulcanite syringe, capable of containing about two drachms of fluid, and having a short nozzle. To this nozzle is fixed, in a movable way, a fine silver canula (Fig. 32) six centimetres in length, and having a lumen of one millimetre in diameter. The one end of the canula has a funnel-shaped opening, which fits accurately over the nozzle of the syringe. The other end, which is as small as possible, is bent at an obtuse angle, and is intended for introduction into the middle ear through the perforation in the membrane. In order that the syringe and the hand of the operator may not obstruct the view, the canula has another bend in the opposite direction, near its attachment to the nozzle. The canula may be connected with the nozzle of the syringe through the intervention of a small piece of India-rubber tubing. This arrangement prevents the motion of the thumb,

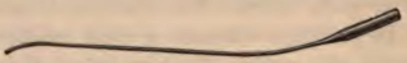

FIG. 32.—Canula for intra-tympanic syringe.

in depressing the piston of the syringe, being communicated to the silver tube, which force might propel its point upon the mucous membrane of the tympanum, causing pain and probably injury.

When the sensitiveness of the parts is such that the hard metallic point of the tube cannot be tolerated by the patient, I make use of a piece of the small tympanic tube (Paukenröhrchen), introduced by Weber-Liel, for conveying fluid into the tympanum by the Eustachian catheter (see p. 111). This piece of the Paukenröhrchen should be six centimetres long, and should include the widened end which can be fitted on to the nozzle of the syringe. The material of which this tympanic tube is made, on account of its softness and elasticity, produces no irritation; but, on the other hand, these same qualities render it liable to be displaced from its position when the stream of liquid is forced through it.

Dr. Blake, of Boston, described another form of middle ear syringe in the *American Journal of Otology* for January, 1880. In his syringe the canula is fixed to the syringe by a screw, and, when a medicated solution is to be employed, the canula is first removed, and a small glass tube screwed on to the nozzle of the syringe. The medicated fluid is drawn into the glass tube, to the outer end of which the fine canula is then screwed, and the injection used.

The solution, after being warmed, is drawn into the syringe, the silver canula of which is then carefully passed through the speculum into the inner end of the external auditory canal. Its bent point, directed upwards, is cautiously placed in the aperture from which the pus was seen to exude. When the point of the canula is in proper position, the syringe being held between the index and the middle fingers of the right hand, the piston of the syringe is pressed slowly inwards with the thumb. If there is an

India-rubber tube connecting the canula with the syringe, when the point of the canula is in position, its outer end is held between the thumb and index finger of the left hand, the latter being steadied by resting the remaining three fingers upon the side of the head. At first a stream of only feeble force should be used, and only one or two syringefuls injected at a sitting; afterwards, however, a stronger stream and four or five syringefuls may be injected with advantage.

There are great differences among patients in the degree of sensitiveness of the mucous membrane of the middle ear to the touch of the instrument. Many seem to have little, if any, discomfort; while, on the other hand, a few are not able to tolerate the pressure of the metallic canula. Sometimes slight giddiness is complained of, while the stream of fluid is passing upwards, but this is rarely severe, and after a few applications it is no longer experienced.

By the use of the syringe we often succeed in dislodging and bringing away considerable quantities of cheesy-looking or epidermic masses. Generally, however, several sittings are necessary, at intervals of two or three days, before such material is removed.

Syringing by the Eustachian Tube. The injection of fluid is usually done with an ordinary syringe through a catheter, introduced in the usual way into the pharyngeal mouth of the Eustachian tube. This method must never be employed unless there is perforation of the tympanic membrane. As wide a catheter as possible should be selected, and its beak should be well inserted into the tube, and then held *in situ* as directed at p. 17, while the fluid is slowly injected into the mouth of the catheter. The injection is more effective, if the patient breathes through the almost closed mouth. Generally a considerable portion of the fluid escapes into the nasal passages and pharynx, although frequently there passes through the Eustachian tube a quantity sufficient to be seen in the external auditory canal.

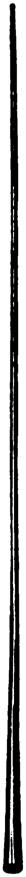

FIG. 33.—Paukenröhrchen or small tympanic tube.

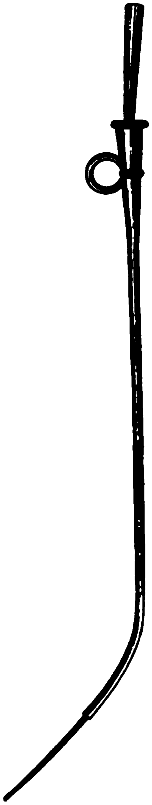

FIG. 34.—Small tympanic tube (Paukenröhrchen) introduced through catheter.

The fluid is sometimes more effectually injected into the tympanic cavity through the Paukenröhrchen passed through a catheter as far as to the tympanic orifice of the tube. This is an elastic tube (Fig. 33) seventeen centimetres in length, and from one to one and a quarter millimetres in thickness. One end of it is widened into a funnel-shaped orifice, and at the other end is a small opening, sometimes placed sideways, to give passage to fluid. In introducing this instrument, a catheter is first passed in the usual way, and through this the tympanic tube is pushed into the Eustachian tube (Fig. 34). The point of the instrument is known to be in its proper position when, by means of a mark at the widened end, it is known to have passed from two and a half to three centimetres beyond the point of the catheter.

When *both* tympanic membranes are perforated, Gruber's method of washing out the middle ear through the Eustachian tube is a simple and good one. This consists in forcing fluid into the nasal passage by means of a syringe furnished with a nozzle, which fits tightly into one nostril, while the other nostril is closed with the fingers. The act of swallowing is performed by the patient, as in Politzer's method of inflation, while the piston of the syringe is pressed home. This method must never be employed if the perforation is limited to one ear, as the fluid forced into the sound one may do mischief.

IV.—Application of Fluids or Vapours to the Mucous Membrane of the Middle Ear.

(*a*) *Fluids.*—For this purpose a small graduated syringe (Pravaz, Fig. 35) capable of containing ten minims of fluid is employed. A wide catheter, having a long beak, should, if possible, be used, while the point of the beak is to be pressed well into the mouth of the Eustachian tube. The catheter, after being properly introduced, is held in position

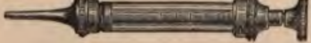

FIG. 35.—Syringe for intra-tympanic injection.

with the left hand; and the syringe, which has been filled with the warmed fluid, is introduced into the outer opening of the catheter, and the fluid slowly and without much force injected into the catheter. The position of the patient's head should be such as to allow of the catheter being horizontal, so that the fluid may not flow out of the catheter. By means of the air-bag a stream of air is then forced through the catheter, and the fluid is driven through the Eustachian tube and distributed as a spray upon the walls of the tympanic cavity. If the fluid is intended only for the Eustachian tube, the bag should be compressed with little force, or the fluid blown in with the mouth. If the head is inclined to the affected side and bent slightly forwards, the fluid may flow into the cartilaginous part of the Eustachian tube without the stream of air.

In forcing the fluid through the Eustachian tube a portion always flows back into the nasal passages and throat. This may be partly due to the catheter not being accurately inserted into the Eustachian tube, but it is mainly owing to the partial hindrance presented by the isthmus tubæ to the passage of the fluid. Owing to this constricted portion of the Eustachian tube, probably more constricted from swelling of the mucous membrane, only the central part of the stream can pass to the tympanum; the rest is forced back into the pharynx. Coughing or retching may be excited by the fluid, but this soon passes off. When the fluid passes into the tympanic cavity, bubbling râles are heard during auscultation—one or two bubbles are often heard even after the inflation is over. A sensation of fulness and warmth is usually experienced in the ear. Pain is very rarely complained of, and inflammatory reaction almost never occurs, when suitable fluids are used. Simple warm water may be employed for injection into the middle ear; but a variety of solutions are recommended. Probably the safest and most useful are solutions of one or other of the following substances—bicarbonate of soda, chloride of ammonium, and iodide of potassium (f. 46 to 49).

This method of treatment is employed chiefly in chronic adhesive catarrh of the middle ear. The object of these solutions is to irritate or stimulate the condensed, thickened or rigid mucous membrane, so as to help to soften and render it more flexible, as well as to promote the absorption of the interstitial new-formation. It is right to state that some aural surgeons believe that the good effects obtained by injecting solutions into the middle ear are in reality due to the air pressure, which, of course, is produced along with them. The preponderance of evidence shows, however, that cases, which have not been benefited by the simple air-douche, have afterwards improved by the use of injections.

(*b*) *Vapours and Gases.*—These are employed in two forms —1. Simple watery vapour or watery vapour impregnated with various medicaments. 2. Air impregnated with volatile substances, such as turpentine, chloroform, etc.

Watery or medicated vapour is employed in the following way:—A wide-mouthed bottle, containing the fluid to be vaporized, is closed with a cork having three perforations. A thermometer is passed through the central aperture, while the other two apertures are filled up by two bent glass tubes. To the outer end of the one glass tube is connected a piece of India-rubber tubing attached to an air-bag, while the other glass tube is connected with another piece of tubing for conveying the vapour to the catheter. The air-bag has an opening in its side for the admission of air. The bottle is heated with a spirit lamp, and the vapour is forced into the catheter by compressing the air-bag while the aperture for the admission of air is closed. The vapour of sal-ammoniac in the nascent state is highly spoken of by some surgeons, especially by von Tröltsch.

Three bottles are here required, containing respectively, strong ammonia, hydrochloric acid, and water slightly acidulated with sulphuric acid. The vapours of the two first substances are conveyed by glass tubes to the upper part of the bottle containing the acidulated water, in which the gaseous chloride of ammonium is formed. A tube leading from this bottle carries the vapour to a catheter introduced into the Eustachian tube. The introduction of chloride of ammonium in this way is attended by considerable trouble as well as some danger of injuring the ear, and the substance is more simply and probably more effectively applied in the liquid form as already described. In the introduction of vapours to the interior of the middle ear, the point of the catheter should be well inserted into the mouth of the Eustachian tube, and retained there either by means of a nasal clamp or the fingers of the patient, while the vapour should be applied for four or five minutes each time. Slight coughing or retching or a sensation of burning in the throat may be excited during and after the application of the vapour.

Air impregnated with certain volatile substances can be applied much more thoroughly and easily than watery or medicated watery vapour. A few drops of the volatile substance, such as turpentine or chloroform, are poured into the air-bag and allowed to volatilize, when the air containing the vapour is forced by compression of the air-bag into a catheter properly introduced into the Eustachian tube. Or, what is probably still better, the mouth-piece of an air-bag, which is firmly compressed with the hand, is placed inside the mouth of a bottle partially filled with the volatile fluid, and the bag is then allowed to fill with the vapour in the upper part of the bottle. Inflation is then performed through the catheter in the ordinary way. In using carbonic acid gas, the air-bag is held in the same way in a bottle containing a solution of bicarbonate of soda, to which tartaric acid has just been added.

Vapours and gases are used by aural surgeons mainly in the treatment of chronic dry catarrh of the middle ear. Their therapeutic effects are probably chiefly exerted upon the lining membrane of the cartilaginous part of the Eustachian tube, for only a small portion can pass beyond the isthmus tubæ into the cavity of the tympanum. The best effects are attained by the inflation of air impregnated with volatile substances. If the vapour or gas reaches the tympanum, a temporary feeling of fulness and pressure is often experienced, while a hot or even burning feeling is sometimes produced in the ear. The deafness or noises in the ear, for the relief of which vapours are usually employed, may for a short time after be aggravated.

V.—Incision of the Tympanic Membrane; Paracentesis.

Various forms of instruments are used for incising the membrane. Schwartze employs a strong double-edged cataract needle. Politzer uses a lance-shaped (Fig. 36 *a*) two-edged needle, about two and a half inches in length, connected by means of a small screw with a handle, the arrangement being such that the incision in the tympanic membrane may be made either in a vertical or horizontal direction. Gruber employs a narrow curved sharp-pointed blade (Fig. 36 *e*), which can also be fitted to the handle to suit any direction in which the incision may be required. In these instruments the blade or needle is connected to the handle at such an angle, that, while operating, the hand of the operator does not interfere with his view of the parts in the ear. In my own practice I prefer the small narrow blade of Gruber, because it takes up rather less space than the lance-shaped instrument.

In most cases, before operating, the middle ear should be inflated by Politzer's method, or with the catheter, in order to increase, as far as possible, the distance between the tympanic membrane and the inner wall of the tympanum. As wide a speculum as the canal of the ear will accommodate is introduced, and the interior is illuminated by means of a mirror attached to the head. The patient's head is firmly held by an assistant, while both patient and operator are seated. The auricle and speculum are supported as in the examination of the ear. The blade or needle is passed through the speculum, and, when the point is close to the part of the membrane to be incised, the membrane is quickly pierced, and the opening at once enlarged to about three millimetres in length. If there is a distinct bulging of a particular part of the membrane, that is to be selected as the place for the incision. When there is no special bulging, a point midway between the umbo and the postero-inferior part of the periphery of the membrane, is probably the most accessible part, while here also the membrane is pretty well removed from the inner wall of

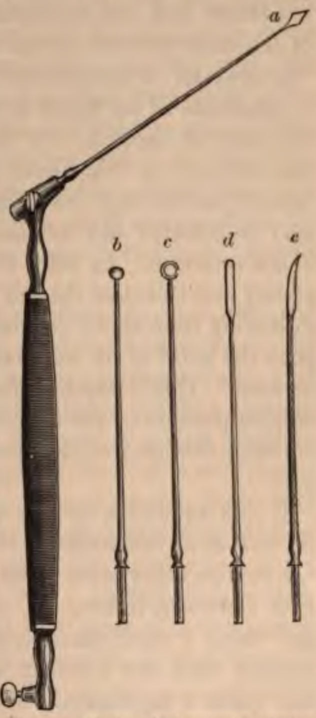

FIG. 36.—Various instruments suitable for the same handle—*a*, Lance-shaped needle for paracentesis; *b*, sharp spoon; *c*, ring knife for removing polypi; *d*, knife for cutting the posterior fold; *e*, curved blade for paracentesis.

the tympanum. The antero-inferior quadrant of the membrane is also a suitable place for the incision, unless, as we sometimes find, the projection of the anterior osseous wall of the canal prevents access to this part of the membrane. The operator, if inexperienced, may fail from over-timidity to penetrate all the layers of the membrane, or he may make too small an opening. In the latter case the secretion in the cavity of the tympanum, especially if tough and stringy, cannot pass through the small opening, the edges of which may be irritated and inflamed by the pressure upon them of the secretion. In order that the membrane may be completely penetrated in the full length of the incision we must in cutting from above downwards or from behind forwards push the point of the instrument inwards while making the incision. This is required from the fact that, owing to the oblique position of the membrane, the upper and back part is nearer the hand of the operator than the lower and front part.

If the exudation in the middle ear is thin or serous, it will flow immediately through the opening into the external auditory canal, from which it may be wiped away with absorbent cotton. If, on the other hand, it is thick and viscid, a small pearly-looking ball is usually seen protruding from the opening, and the patient by performing the Valsalva experiment, or even simply blowing the nose, is frequently able to assist in its expulsion. Inflation by Politzer's method is, however, often necessary to help in forcing out the secretion; while suction with Siegle's speculum may be of service. When the secretion consists of very viscid mucus, forceps may be required to pull it out of the opening of the membrane, and the mucus is sometimes thus drawn out in the form of a string.

It is occasionally necessary, before we are able to empty the tympanum, to soften or thin the secretion by means of solvent fluid introduced into the tympanic cavity. This may be done either by injecting eight or ten drops of warm water, or a weak warm solution of bicarbonate of soda, through the catheter and Eustachian tube into the tympanum; or a similar solution may be cautiously injected into the cavity of the tympanum through a small tube, such as the "Paukenröhrchen," introduced through the opening in the membrane. A simpler, though perhaps a less effective, method consists in pouring the warm solution into the external auditory canal and allowing it to remain there for a few minutes, during which the tragus is frequently pressed in upon the fluid.

Paracentesis of the tympanic membrane is rarely attended by severe pain. When there is distinct pointing of the membrane the operation is almost painless, and, even when there is no pointing, it is equally painless in some individuals. When the pain is sharp, it is but momentary. It is rarely attended by the flow of more than a mere drop of blood, and the wound usually heals very quickly. In twenty-four hours a black streak of dried blood marks the site of the incision, which has usually healed up. Inflammatory complication is rare. In Politzer's experience only four such occurred in 1500 cases of the operation. It is nevertheless always a judicious precaution that the patient should for the remainder of the day after the operation rest in the house, and avoid alcoholic stimulants.

This operation is practised in two classes of cases:—1st, when there is purulent, mucous, or serous exudation in the cavity of the tympanum, or in the interstices of the tympanic membrane; and, 2nd, in cases of chronic simple catarrh, with no fluid exudation, and in which tinnitus is a prominent symptom. The propriety of the operation in the former class of cases cannot be gainsaid, as it is based on ordinary surgical principles. With acute purulent collection in the middle ear, where the tympanic membrane has become thickened and more unyielding, in consequence of previous disease, the operation is eminently called for. In such a case timely incision of the membrane may prevent the extension of the disease to the labyrinth, or to the meninges. In mucous or serous exudations in the middle ear the operation is indicated, 1st, where the quantity is so great as to cause a distinct saccular bulging of the membrane, especially at its posterior part, a condition not unfrequently met with in children; and, 2nd, when the mucus is thick and viscid, although not in such quantity as to produce distinct bulging. Here the operation, timely performed, may avert important and permanent structural changes in the tympanum. The author's experience of cutting operations in the tympanic membrane, where no fluid exudation exists, has not convinced him of their value. There is at times more or less transient improvement in the hearing or in the tinnitus, but permanently good results are rare. On the whole experience seems to show that the operation of incising the membrane is of value mainly in cases of fluid exudations in the middle ear, and in these cases only a small proportion will recover without subsequent treatment. Repeated inflation by Politzer's method is usually required for some time afterwards.

VI.—Rarefaction and Condensation of Air in the External Auditory Canal.

Traction upon the tympanic membrane by rarefaction of the air in the external auditory canal is sometimes useful in conjunction with inflation of the middle ear. This rarefaction may be produced either rapidly or gradually. Rapid but moderate suction may be brought about by Siegle's pneumatic speculum (Fig. 8). A convenient method, which may be used by the patient at home, requires simply an air-bag and an India-rubber tube, similar to that used for inflating the middle ear (see p. 27), substituting for the soft-rubber nasal piece an ear-piece, of conical shape covered with India-rubber tubing, so as to make the closure more complete. The air-bag is emptied and compressed with the hand, and the ear-piece fitted air-tight into the external auditory canal. The compression exerted by the hand is then removed, and the air in the canal is rarefied and traction thus exerted on the membrane. This may be repeated four or five times at each sitting. Woakes' pneumatic tractor is possessed of greater power than either of these methods. A pear-shaped bell, more or less exhausted of air, is fitted by means of a suitable ear-piece into the external meatus, and the suction thus produced is allowed to go on for eight or ten seconds. By great exhaustion of the air in the bell very great power of suction may be obtained. The contrivance of Dr. Woakes should only be employed by the surgeon himself, as it is capable of exerting a dangerous amount of traction. A method of gradual suction has been suggested by Politzer, and consists in soaking a piece of cotton in oil, and making a firm plug of the size of a hazel nut, which is then packed into the cartilaginous part of the external auditory canal. This is done at night and removed in the morning. It is repeated two or three times weekly for two or three weeks, and produces the desired effect.

This method of treatment by rarefaction of the air in the external auditory canal is called for especially when the tympanic membrane is much indrawn or retracted, along with adhesions or retraction of the tendon of the tensor tympani muscle. The gradual method is also suitable where the membrane is flaccid or atrophied.

VII.—Electricity.

Electricity is employed in the treatment of ear disease in the form of the continuous and the induced current, as well as for its thermic effect (galvanic cautery).

For applying the continuous current, the writer uses a zinc and carbon battery having twenty-one cells, furnished with a commutator for reversing the direction of the current; and for the interrupted current (Faradism), Dr. Spamer's portable induction apparatus.

Various forms of electrodes are required, according to the method of application. The writer most frequently employs it by way of the Eustachian tube and external auditory canal. The electrode from the positive pole is introduced into the external auditory canal, and consists of a conducting wire passing through a vulcanite speculum, the end of the wire being capped with a piece of sponge, which projects from the inner end of the speculum (Fig. 37). When introduced, the sponge is in contact with the walls of the canal, or, by pushing the speculum farther in, is placed in contact with the tympanic membrane. Before introduction, the sponge is moistened in a warm weak solution of salt. The negative electrode consists of a conducting wire passing through a thin Eustachian catheter, the wire terminating in a small metallic ring which tips the inner end of the catheter. When used, the point of the catheter is introduced well into the pharyngeal mouth of the Eustachian tube, and the catheter is held *in situ* by the patient. The positive electrode is sometimes placed at the outer orifice of the ear, or over the tragus, instead of in the canal, by means

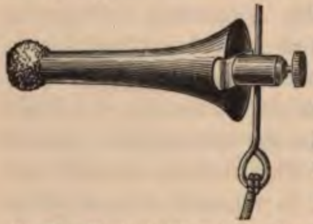

FIG. 37.—Electrode for applying electricity to the interior of the ear.

of a bent metallic stem having a ball-shaped extremity covered with leather, while the other electrode, having a similar shape, is placed over the side of the neck. Electricity is also sometimes applied by filling the canal of the ear with warm solution of salt, into which the end of the electrode is placed. In galvanizing the sympathetic, one pole is placed under the articulation of the jaw at the inner edge of the sterno-mastoid muscle, and the other electrode in the situation of the lower part of the common carotid. In using the continuous current it is often advantageous to alternate the direction of the current.

Galvanizing the ear, for therapeutic purposes, should not be employed more frequently than twice a week, and only for eight or ten minutes on each occasion. We must not employ a current so strong as to excite pain, burning, marked facial contractions, flashes of light, loud sound, or giddiness. During galvanization of the ear a sensation of taste or contraction is sometimes experienced in the tongue, the impression being conveyed through the chorda tympani nerve, lying on the inner surface of the membrane.

There are great varieties of opinion among aural surgeons as to the therapeutic value of the electric current, some extolling it as one of the most valuable remedies, while others deny its having any real or permanent usefulness. This difference of opinion is probably due to the uncertain data upon which we are able to select this remedy, or the form of electricity to employ. When there is evidence of hyperæsthesia of the auditory nerve, with subjective sounds in the ear, galvanic excitement of the nerve should be avoided. On the other hand, if there is torpidity of the nerve (dysæsthesia), there is reason to expect benefit from the employment of the galvanic current. When the acuteness of hearing is liable to marked fluctuations, which are not accounted for by changes in the middle ear, the galvanic treatment should be tried. In chronic adhesive catarrh of the middle ear part of the impairment of hearing is probably sometimes due to functional disturbance of the nerve, which might be benefited by the galvanic current; and, at any rate, the nervous symptoms, which sometimes exist in connection with that affection, are occasionally relieved by electric treatment.

Faradism is applied to the ear generally with the object of acting upon the muscles of the middle ear, especially the tubal muscles. Paretic conditions of one or all of these muscles are undoubtedly present in a certain number of cases of deafness or tinnitus. It is most efficiently applied according to the first method described. The statement that Faradism has any beneficial effect in the way of shakening or loosening a rigid ossicular chain (Woakes, Field) has no clear evidence to support it.

It has to be observed that either form, in some cases, seems to aggravate the noises in the ear, and, if so, this mode of treatment should not be continued.

The Galvanic Cautery.—In the treatment of the morbid conditions of the nasal and pharyngeal cavities, and of the ear, the galvanic cautery has of late years been largely employed, both for destroying morbid tissue and removing growths, when the cold iron loop was insufficient.

The application of the electric cautery to the ear through the external auditory canal has been less employed than to the nasal and pharyngeal cavities, especially in this country, probably owing to the fear of injuring the healthy tissue in a cavity so limited in size. By the German surgeons, however, this mode of application has been much more recommended and used. Since the time of Middeldorpf, who was the first to suggest its use in otological surgery, this method of treatment has been advocated and employed by such men as Jacob of Breslau, Schwartze of Halle, Voltolini, Hedinger, Politzer, Gruber, Urbantschitsch, Purvis, and others.

The battery* which the writer employs consists of eight large plates, four of zinc and four of carbon arranged alternately. The zinc plates are united and the carbon plates united, the two sets being connected through the electrodes; in this way the maximum thermic force is attained. The plates are held together by an iron rod covered with vulcanite, and passing through holes in the plates. A brass handle is attached to this rod, by which the plates can be moved as desired. The exciting fluid consists of a ten per cent. solution of bichromate of potash, to which the same proportion of sulphuric acid is added. Twelve pints of this fluid are contained in an oval earthenware basin, giving a depth of seven inches of fluid. This vessel with the fluid lies on the floor of a wooden box. A wooden rack, having eight spaces, is fixed on each side of the box; and these spaces accommodate the ends of the iron rod which supports the plates.

This is a convenient form of battery, for it emits no smell, and the plates require no cleaning after being used. The exciting fluid need not be changed oftener than once in the three months, although the battery is employed daily. It is always reliable, and after finishing an operation, we simply require to lift the plates into the upper part of the rack, and close the lid and door of the case.

The handle of the cautery should be small and light, measuring about two and a half inches in length. The arrangement for interrupting and restoring the continuity of the current is usually at one side. The insulated electrode must be very slender, and bent at an obtuse angle. It is pretty much of the dimensions of an aural probe. Hence, when introduced into the ear, nasal passages, or throat, it takes up very little space, and the view is only very slightly obstructed.

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* Made by Mayer & Wolf, Vienna.

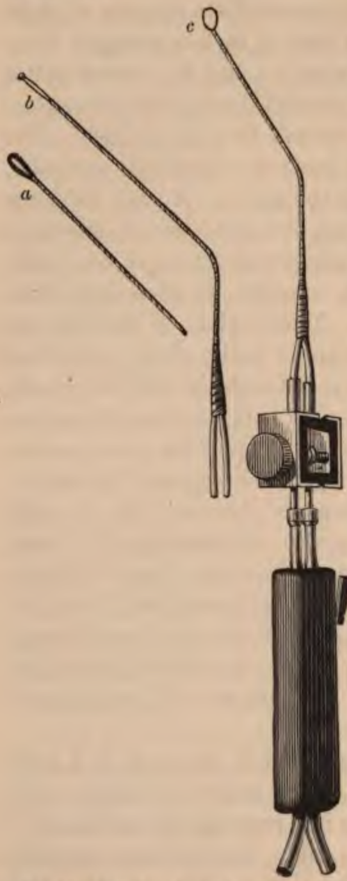

FIG. 38.—Handles, electrodes, and burners of galvano-caustic apparatus: *a*, ribbon-shaped burner; *b*, disc-shaped burner; *c*, galvano-caustic loop.

The burners (Fig. 38) for cauterizing morbid tissue are of three kinds, and are all, of course, composed of platinum. One consists of thin platinum wire, coiled in such a way as to present a small round disc to the diseased tissue. A second form is ribbon-shaped, and is about two millimetres broad. It has the advantage over a wire loop of presenting a broad surface to the tissue which has to be burned. The third form of burner is simply bent platinum wire, and presents a linear surface to the parts. For the ear as wide a speculum as possible is employed; for the nasal passage Baber's speculum is suitable.

While good light is projected from a forehead mirror, the burner is introduced cold through the speculum, exciting no fear or anxiety in the mind of the patient. When it has been accurately applied to the morbid tissue a slight pressure of the finger upon the spring at the side of the handle, is instantly followed by a red-hot condition of the burner and the thorough cauterization of the tissue. This is accompanied by a hissing sound and by the obscuring of the parts by vapour. For about two seconds the tissue is exposed to the red heat, and then the current is interrupted. The burner instantly cools, the instrument is withdrawn, and the patient need not be aware that a red-hot metal has been in the interior of his ear or nasal passage. If required, the burner may be reintroduced and reapplied two or three times at one sitting. It is very important that all moisture should be carefully removed from the part to be cauterized before the application of the burner, otherwise a longer contact of the burner with the tissue is required. The galvano-caustic loop (Fig. 38) consists of two fine tubes covered with insulating material and bent at a suitable angle. The two ends of a platinum wire of sufficient length are passed through these tubes and then through apertures in a revolving barrel. By rotating the barrel, the wire loop formed at the distal ends of the tubes is gradually made smaller, and we thus form a loop suitable for the size of the growth. The wire loop is first made to encircle the tumour as near the root as possible, and the barrel is turned by the left hand, until the wire loop has tightly embraced the substance of the growth. The current is now put on, the barrel is simultaneously turned, and the red-hot wire passes through and severs the growth without difficulty or even resistance. The current is then interrupted, and the tumour with the instrument is removed. It is to be noted that the red-hot wire becomes more and more removed from the walls of the passage, into which it is introduced, while the loop is being gradually diminished in size by the winding of the barrel. It is thus nearly impossible to burn the healthy tissue. The more nearly we get the loop to the root of the growth the shorter will be the time required for after-treatment. I have not seen any inflammatory mischief result from the use of the galvanic cautery. The pain, while somewhat sharp at the moment of application, rarely, if ever, continues, thus presenting a marked contrast to some medicinal caustics, such as chloro-acetic acid.

The various conditions for which this mode of treatment may be required are, fibrous polypi and hypertrophied mucous membrane in the ear, caries, nasal polypi, hypertrophied mucous membrane in the nasal passages, adenoid vegetations, follicular pharyngitis, and enlarged tonsils. It is also employed to make an artificial opening in the tympanic membrane.

VIII.—Artificial Aids to Hearing.

Mechanical contrivances for concentrating or strengthening the effect of sound upon the ear are frequently of great benefit to persons, whose hearing is very defective. Most frequently a deaf person uses his own hand or fingers to press the auricle forwards and outwards or to increase the reflecting surface behind, so that the sound waves coming from a point in front of him are more completely caught and reflected into the ear. This simple method is often a considerable help.

As an artificial aid to the hearing of speech, when the speaker is near, as in ordinary conversation, a flexible tube, the conversation tube (Fig. 39), is the most effective. This is about three feet in length, composed of silk or wool woven upon a tube of iron wire arranged spirally, and having a mouth-piece and an ear-piece made of horn. The mouth-piece should be fun-

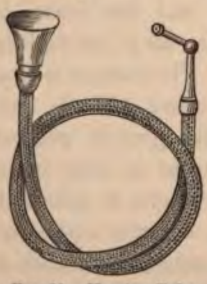

FIG. 39.—Hearing Tube.

nel-shaped and about two inches in diameter at its outer opening; during use the mouth-piece is held in front of but not in contact with the speaker's mouth, and ordinary loudness of speech is employed. The ear-piece is acorn-shaped, smoothly rounded, and is placed in the external orifice of the patient's ear. It should be bent to almost a right angle about an inch from the end, and the horn should extend from four to five inches upwards, so that the hand of the patient may not wear and impair the flexible, softer part of the tube. Such a tube can be conveniently coiled and carried in the coat pocket. When the external meatus is very irritable, the ear-piece should be shaped like an oval shell, and made to accurately cover the auricle. For use at table a longer tube with a wider mouth-piece, which may rest on a suitable stand, is sometimes convenient. There is greater concentration of sound if the tube becomes gradually somewhat narrower from the mouth-piece to the ear-piece.

It is much more difficult to enable the deaf patient to hear a speaker at a distance. Probably the most suitable instrument for this purpose is a conical tube having a wide mouth, shaped like a speaking trumpet or horn of a cow, and made of silver, vulcanite, or horn, the ear-piece being placed at a right angle with the rest of the tube. A parabolic metallic cup fitted to a tube with an ear-piece is found by some persons to be more effective than the simple wide-mouthed conical tube.

In imitation of the efforts of deaf patients to improve their hearing by placing the hand behind the ear, instruments are made which are fitted by means of clamps behind the auricles, pushing the latter forwards and increasing the surface for the collection of sound. This form is specially suitable for those whose auricles have been much flattened by the compression of caps, &c., and is, to the patient, probably the most agreeable, though not the most effective.

Small instruments, invisible during use, for augmenting the hearing power are in great request by deaf persons, who in consequence of their great inclination to conceal their infirmity dislike and delay the employment of the somewhat conspicuous appliances just described. These so-called invisible tubes are generally worthless, unless in cases where the defect of hearing is due to collapse of the cartilaginous walls of the canal. Politzer has recently introduced a small tube, the shape of a hunting-horn, made of vulcanite and about an inch in length. The narrow end is introduced into the meatus, and the mouth of the wider end is directed to the hollow of the concha. The object of this contrivance is to increase the normal effect of the inner surface of the tragus in reflecting the waves of sound, coming from the concha, into the external canal. Politzer has found that, in about three-fourths of the persons on whom he has tried the instrument, the hearing was improved, on an average, to the extent of double their ordinary distance, while in a fourth the hearing was either not improved or made worse.

In any given case we should try each of these various contrivances,* until we find the one which is most beneficial. The improvement of hearing derived from the use of one or other of these instruments is often of great benefit to deaf persons, and the relief to their friends is also a not unimportant advantage. It is to be remembered, however, that some persons with hyperæsthesia acoustica cannot tolerate the use of the hearing tube owing to the painful sensation produced upon the ear, when words are spoken into it. These aids are not to be employed in cases of recent deafness from acute inflammations. In old standing cases, however, there is no objection to their use, provided they prove comfortable and beneficial. Indeed, by applying to the auditory nerve its proper stimulus—sound vibrations—the use of these appliances may prevent or delay the atrophy, which is apt to result from the deprivation of the proper stimulus of the nerve.

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* Many varieties of these hearing apparatus may be seen depicted in Maw's Catalogue, London, 1882. F. C. Rein & Son, 108 Strand, London, also supply every variety.

Recently there has come from America a new instrument for "enabling the deaf to hear"—the *audiphone*, introduced to the profession and to the public with fair promises; but, unfortunately, the test of experience has proved its performances to be very meagre and disappointing. The audiphone consists of a thin plate of vulcanite, nine inches by ten inches, furnished with a handle. By means of a silk cord it may be bent to any degree of curvature and tension. Before the instrument is used, the cord is pulled so as to give the required curvature, and the upper edge is placed in contact with the upper incisors, or pressed between the upper and lower incisors, while it is held with the convexity forwards. The conduction of sound through the bones of the head is the basis of this American invention, and it is asserted that the waves of sound coming from the speaker's mouth and falling upon the convex surface are transmitted to the teeth, thence through the bones of the head to the labyrinthine fluid and nerve, independently of the external and middle ear. Theoretically this is a very reasonable direction in which to seek for a means of helping those deaf persons, whose auditory nerves are healthy, and where serious obstacles exist to the normal transmission of sound through the conducting part of the ear. But in making use of osseous conduction the vibrating body must be placed in contact with the bones of the head; and while, in the case of a deaf person, whose auditory nerves are intact, the music of a piano may be quite well heard, if the vibrating sounding board is directly connected by means of a rod of wood with the teeth or bones of the head, it is very different if there is not the direct connection of a solid sound-conducting substance. What has to be discovered is a solid substance, which shall have the property of being set into vibration by waves of sound transmitted through the air of no greater intensity than those produced by the human voice in ordinary conversation. The audiphone is possessed of this property to only a very small extent, and hence we find that it is quite useless in the great majority of cases. Out of very many cases in which the writer has tested it, he can remember only two in which it was clearly useful, and in these a piece of cardboard, bent, and in a state of tension, was equally serviceable. While it is generally useless in aiding the hearing of speech, it is probably more effective in enabling a very deaf person to hear loud music. A rod of wood connecting the larynx of the speaker with the teeth of the deaf person has been suggested as a means of enabling a deaf person to hear speech. For obvious reasons this is not likely to become popular with those whose throats have to be pressed upon by such a rod of wood.

IX.—*The Artificial Tympanic Membrane.*

Yearsley, in 1848, was the first in this country to draw attention to the improvement in hearing, which is sometimes produced by placing a moistened pellet or ball of cotton wool over the remains of the tympanic membrane in cases of perforation. Toynbee, making use of the suggestion, introduced in 1853 his so-called artificial drum (Fig. 40), which consists of a disc of India-rubber connected with a silver wire. This silver wire is fixed at the one end into the centre of the disc, by means of two very fine silver plates, while the outer

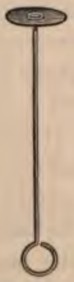

FIG. 40.—Toynbee's artificial tympanic membrane.

end of the wire is formed into a ring for convenience of holding. Modifications of the original membrane of Toynbee are used by some surgeons. Gruber substitutes for the wire a thread, which is passed through the centre of the disc. The disc is, in this case, introduced into the ear by means of forceps, or of a vulcanite tube. The thread is passed through the tube so that the disc rests on the inner end of the tube. This is introduced, pushing the disc before it, until the latter is placed in proper position, when the tube is withdrawn. A small piece of soft lint is sometimes used instead of India-rubber. A fine India-rubber tube, cemented at its inner end to the disc, is also sometimes employed instead of the wire. Whichever of these modifications is used, the disc should be cut to the proper size, and, before being introduced, it should be moistened with warm water or vaseline. If we use Toynbee's membrane, or any kind of disc with a wire attached, the latter is held by its ring-formed end, and the disc is gently pressed down the canal of the ear, till there is a feeling of obstruction, when it will be usually found to rest on the remains of the membrane. If it produces a ringing in the ear, or other unpleasant feeling, or if no improvement in hearing takes place, its position should be modified. Several alterations are often necessary before it is efficient and comfortable, and after a little practice the patient is better able than the surgeon to make these adjustments. When it acts efficiently, the patient often knows simply by the sensation in his ear, or he finds, by applying such a test as creating a slight noise with his finger-nails or the rustling of his clothes, that he hears better.

The use of the cotton ball or pellet of Yearsley, or some modification of it, is now generally preferred by aural surgeons to the India-rubber disc. The cotton is sometimes used dry, especially when it is intended to soak up moisture in the ear; but a moistened ball of cotton is, in my experience, much more effective in improving the hearing. It may be moistened with glycerine well diluted with water, or with vaseline. If there is still suppuration, it may, with advantage to the suppurative process, be soaked in a suitable astringent, or antiseptic solution. The cotton may have the form of a ball, or it may be disc-shaped (in the latter case two or three layers of surgeon's lint, connected together with thread, are preferable to the cotton wadding), while a piece of thread attached to it, and which lies in the canal of the ear, while the cotton is in position, enables the patient to remove it at will. The cotton is introduced by means of fine forceps having a weak spring (Fig. 41). When the surgeon has satisfied himself of the usefulness of the cotton pellet, he should carefully instruct the patient in the method of introducing and withdrawing the cotton. Very frequently, after such training, the patient becomes much more dexterous than the surgeon in manipulating the cotton in the ear.

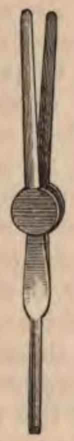

FIG. 41.—Forceps for introducing cotton pellet.

The use of the cotton has the following advantages over Toynbee's artificial membrane—1st, It is softer and excites much less irritation; 2nd, It is a convenient medium for applying astringents or other medicaments to the interior of the ear; 3rd, It does not cause disagreeable noises in the ear during chewing, as does the wire of Toynbee's membrane; 4th, It is not visible at the orifice of the ear. In very few cases, indeed, is the India-rubber disc useful when the cotton pellet fails.

The efficacy of either form depends very much on the precise place to which it is applied, and the degree of pressure exerted by it. The situation, where it is most likely to be beneficial, is the upper and back part of the inner wall of the tympanum, over the situation of the stapes. The next most likely place is the upper part of the manubrium. If the perforation is small, we should try the application of a small cotton disc over it. But, in determining whether, in a given case, this mode of treatment will prove useful, we must patiently and carefully try the moist cotton pellet on one spot after another with varying degrees of pressure. In many cases we must, before admitting failure, repeat our efforts at two or three different times. As a rule, when we hit upon the proper place, we have the good effect immediately; but I have known patients, who found no benefit until it had remained in the ear several hours.

When we find that this method of improving the hearing is successful, caution should at first be exercised so as to avoid irritating the ear, and producing inflammation or suppuration. Great varieties are met with among patients in regard to the irritability, which may be produced by such a foreign body as a piece of India-rubber or cotton. In a small number it is quite impossible to wear them owing to the irritation produced even by contact for half an hour; while, on the other hand, we meet with those, whose ears can tolerate the contact of moist cotton wad for months at a time without inconvenience. In a large number of persons it is well at the beginning to limit the use to one hour each day for a few days, gradually extending the time, until we reach eight or ten hours per day. Unless there is remarkable tolerance of their contact, neither form should be used at night. During the first few days the patient should be seen daily, and it is well, at first, that the cotton employed should have a piece of thread attached to it, so that the patient may, after the alloted time has expired, remove it.

When acute inflammation exists in the ear, or when there is profuse suppuration, no form of artificial membrane should be applied until these conditions have been removed. It should not be persisted in, when its most limited use excites inflammation or giddiness. It is also inapplicable to young children. We should not recommend it in persons whose hearing is very good in one ear; or even, although both ears are affected, where the deafness is not marked.

These artificial helps to hearing have sometimes an excellent effect, rescuing deaf persons from solitude to all the enjoyments of society. Many persons, without such aid, can hear speech only when spoken close to the ear, while with the aid of a pellet of cotton properly adjusted they hear ordinary conversation perfectly well. Even in cases of almost total deafness decided improvement is occasionally effected, although, as a rule, when the deafness is extreme, no benefit is produced by the artificial tympanic membrane. Slight improvement is very common, and even such moderate improvement may be of great value, perhaps averting exclusion from public meetings. The experience of the writer accords with that of Politzer that an occasional pause of a few days is often followed by still better hearing. We now and again find that improved hearing continues for some time after the removal of the cotton.

It has to be admitted, however, that in a number of cases the artificial support has no effect in improving the hearing, although with greater experience most aural surgeons feel that the number of such cases becomes less. We cannot in any given case determine merely from the pathological conditions present whether this mode of treatment will prove beneficial. The test of experiment is our only guide. Such a test is sometimes provided by the patient before coming to us. If he informs us that the pouring into the ear of a few drops of oil, glycerine, or water has the effect of improving the hearing for a time, we shall, with great probability, find that the moist ball of cotton has a beneficial effect on the hearing.

The way in which the improved hearing is brought about by the artificial tympanic membrane is not fully understood. It is certain that this is rarely due to the mere closure of the gap in the membrane; indeed this has often an injurious effect on the hearing. The good effects are probably produced, in most cases, by pressure exerted upon some part of the ossicular chain, either directly or through the intervention of the remnant of the tympanic membrane. When, on account of disarticulation between the incus and stapes, or when a portion or the whole of the incus has been removed, the continuity of the ossicular chain is lost, the stapes is deprived of its proper support, and fails to exercise a due amount of pressure upon the fluid of the labyrinth. The application of the cotton pellet by pressing upon the manubrium or upon the long process of the incus probably restores the continuity of the chain, or, if the incus is gone, the pressure exercised upon the stapes by the artificial support may restore the due amount of pressure upon the labyrinthine fluid. We frequently find that the cotton has to be well pressed into the situation of the stapes before a beneficial effect is secured.

Knapp believes that, in some cases, the improvement is due to diminishing the tension of the chain of ossicles and thus relieving excessive pressure upon the fluid of the labyrinth. In these cases the pressure of the artificial support is exerted upon the short process of the malleus, which is above the axis of motion of the ossicular chain. The upper arm of the lever is thus pressed inwards, and the lower arm together with the incus and stapes is moved outwards.

Advantage to the hearing has been sometimes derived from the pressure of a moist disc of cotton wad upon the tympanic membrane, when the latter was not perforated. We may suspect in such rare cases that the continuity of the chain of bones has been, from some cause, disturbed.

X.—The Operative Treatment of Aural Polypi.

The safest, simplest, and most effective means of removing a polypus from the ear is by encircling it with a wire loop, as near the root as possible, and then constricting and severing the growth. The instrument used for this purpose is Wilde's snare (Fig. 42) or some modification of it. Wilde's snare consists of a steel shaft bent near the middle at an obtuse angle. To the outer end is attached an oval ring for the reception of the thumb of the operator. The inner end, for introduction into the ear, is about the twelfth of an inch broad, smooth, rounded, and perforated by a short canal at each side for the passage of the wire. At the angle of the shaft there are other two canals for the reception of the wire. A movable cross-piece also perforated by two canals is connected with the outer part of the stem. The end of the wire is first passed through the three canals on the one side, beginning with the cross-piece, and then through the three on the opposite side, beginning at the inner end. A loop of the size desired is then formed by drawing down the two ends of the wire, which should afterwards be fixed by winding them round the cross-piece. When the latter is pressed down with the index and middle finger, any object, which may be encircled with the loop, is constricted. The growth is more effectually

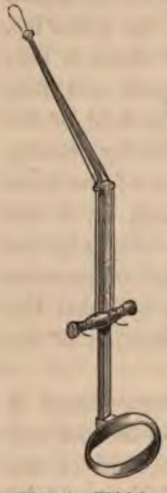

Fig. 42.—Wilde's snare.

divided with the wire, if there is a groove on the distal end of the stem for receiving the wire, when the loop is tightly drawn. There are various modifications of Wilde's snare. In one, instead of a solid stem, there is a tube, through which the wire is passed—this is intended to ensure the complete penetration and division of the growth in order to avoid the necessity for traction. In another modification (Blake and Gruber) a straight stem, having a ring on its under surface for the index finger, is connected with a handle, at an obtuse angle, by means of a fixed screw. Various other instruments, such as a probe, a paracentesis needle, &c., may be substituted for the stem, so that the one handle serves for different purposes. For small soft polypi well annealed iron wire is suitable. If the tissue of the polypus is firm and tough, fine steel wire or thin platinum is necessary. Cat-gut is employed by some, and fine fishing gimp is recommended by Dalby. The objection to these two last substances is that, on account of their softness, it is not so easy to encircle the growth, especially when the situation is not very accessible.

In using Wilde's snare, where the polypus is so large as to protrude from the outer orifice of the ear, the affected side is turned towards good light, and, by means of a probe, the length of the polypus and, if possible, the position of its attachment are ascertained. The snare is then held by means of the thumb in the ring, while the index and ring fingers support the cross-piece. The wire loop, bent at a suitable angle to the stem of the instrument, is made to encircle the outer end of the growth, and then gently insinuated, by a kind of rotatory movement, as far as is possible without exciting very great pain. The cross-bar is then firmly pressed down towards the thumb, and the growth is tightly constricted or completely divided. If the tumour is attached to the walls of the external auditory canal, it need not be cut through, but only tightly constricted, and then if possible pulled out by its root. But if attached to the tympanic membrane, or to the tympanic walls or contents, pulling efforts are to be avoided, and the growth should be completely cut through. If it is attached to the manubrium, to the tympanic membrane, to the stapes, or to a carious piece of bone, great traction might lead to a serious if not a fatal effect. We can rarely remove the whole of one of these large polypi at the first sitting, as it is seldom possible to place the loop at the very root. When we get access to the deep part of the ear, we may find not only the remaining portion of the large polypus, but also other smaller ones occupying the interior of the ear. We frequently find it necessary to use the snare at intervals of a day or two several times, before we are successful in clearing away the whole of the morbid tissue. The bleeding is sometimes considerable, but is usually quickly staunched by pressure with a cotton plug.

When the polypus is not so large as to appear at the outer end of the canal of the ear, the operation must be done with the aid of the forehead mirror, and as wide a speculum as possible. The position of the polypus and its point of attachment should be first determined with the aid of the probe, and the loop is made to encircle it, with the greatest gentleness possible. If the perforation in the membrane is very small and the bulk of the growth situated in the tympanic cavity, it may be necessary to enlarge the perforation before we are able to pass the loop round the growth.

When, as in the greater number of cases of aural polypi, the cellular structure predominates, Wilde's snare used cold will easily and safely effect the removal of the growth. But it is otherwise with a growth which is chiefly fibrous in its structure, whether it is connected with the periosteum or forms one of those large recurrent polypi, which fill the external auditory canal, and project out of the external orifice of the ear. These latter forms of polypi have often an extremely hard and strong texture, and it is not unfrequently impossible to completely sever the tissue of the growth with a cold wire. If the wire is thin and sharp, it lacks sufficient strength, and gives way in our efforts to penetrate the tumour; if one of greater strength and thickness is made use of, it may still fail to penetrate completely the growth; and in order to remove it we must make strong efforts of traction, by which we not only excite great pain, but may drag away some portion of the walls or contents of the tympanum. By the red-hot wire loop the growth is not only quickly and easily severed, but at the same time the part of the growth left is thoroughly cauterized. Bleeding is usually much slighter by this method, although it is a mistake to assert that it totally prevents bleeding. A white heat and a very thin wire is apt to be followed by greater hæmorrhage than a merely red heat and a thick wire.

For the form of battery and mode of employing this method of treatment see p. 124.

XI.—Artificial Perforation of Mastoid Process.

In certain cases this operation is one, which in importance may rank with tracheotomy in diphtheria or with the operation for the relief of strangulated hernia as an operation for the saving of life. We are much indebted to Schwartze of Halle for placing this operation on a more scientific basis. No one has had more experience of it, and by pointing out the true indications for it, and the anatomical difficulties encountered in its performance, he has done good service to aural surgery.

The object of this operation is to make an opening through the shell of bone forming the outer wall of the antrum mastoideum, thus establishing a communication with the antrum, tympanic cavity, and external auditory canal, so that free escape for the purulent secretion may be secured, and thorough cleansing may be employed. The safest method of operating is to remove, by means of a chisel or gouge, layer after layer of bone, working parallel to the dura mater, until we reach the interior of the mastoid cells. In this way the field of operation is constantly before our eyes, and there is not the danger, as in the use of a trephine or bone perforator, of propelling the point of the instrument inwards upon the dura mater.

The parts which may be endangered by this operation, are (1) the lateral sinus in the posterior fossa of the skull, (2) the dura mater, either in the posterior or middle fossa, (3) the canal for the facial nerve, and (4) the external semicircular canal. These are to be avoided by making the opening close to the upper and back part of the external auditory canal, and by not penetrating too deeply. In about forty-one per cent. of the skulls examined by Hartmann, the groove for the lateral sinus was as far forwards as ten millimetres (rather more than $\frac{3}{8}$ of an inch) from the posterior wall of the external auditory canal. In order to avoid the facial canal and the external semicircular canal, we must never penetrate deeper than $\frac{5}{8}$ of an inch.

The following description of the operation is chiefly from Schwartze. After the hair has been shaved off from the neighbourhood of the mastoid process, and the skin sponged with a carbolic acid watery solution, an incision is made through the soft parts close to and parallel with the auricle. The incision should begin about half an inch above the linea temporalis* and should be from one to two inches in length, according to the amount of œdematous swelling, and the soft parts should be completely divided down to the bone. In order to expose a larger surface of the bone, Politzer forms a flap by making a second incision backwards from the upper end of, and at a right angle with, the first incision, and then dissecting the triangular flap from the bone. The bleeding is checked by compression, torsion, or ligature. A careful examination of the surface of the bone is now made, and, if it is found to be soft, the pressure of a knife (cartilage knife) or even of a probe may be sufficient, especially in a child, to perforate the cortex. If the cortex, however, is firm and sound and covered with periosteum, the latter is raised and pushed aside, exposing the bone, to the extent of $\frac{5}{8}$ of an inch. A narrow straight chisel (Fig. 43) is then applied to the surface of the bone at a point about a quarter of an inch below the linea temporalis, which will be slightly behind and below the level of the roof of the external auditory canal. If the linea temporalis cannot be found, it is a good plan to place as a guide, a wooden or cork plug in the external auditory canal, and apply

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* This is a ridge, generally distinctly felt with the finger through

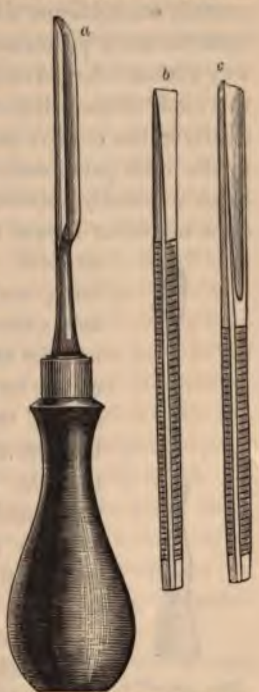

FIG. 43.—Instruments used in perforating the mastoid process: *a*, gouge; *b*, narrow straight chisel; *c*, narrow curved chisel.

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the skin, and is the continuation backward of the upper edge of the zygomatic process. It is on a line with the floor of the middle fossa of the skull.

the chisel close to the junction of the mastoid surface with the external auditory canal, just behind the level of the roof of the canal. The chisel, held at an angle of 45° to the surface, is worked with a wooden hammer inwards, in a direction downwards and forwards. Scale after scale of bone is carefully removed, until we approach the antrum mastoideum, when the narrow curved chisel is used, until we fairly penetrate to the cavity of the antrum. In this way a funnel-shaped opening, wide outwardly, is formed. By this mode of operating, even although there may be any abnormality in the relative positions of the interior of the cranium to the outer parts, such as unusual depth of the middle fossa, or an unusually anterior position of the sigmoid fossa, the dura mater or lateral sinus need not be injured, although exposed. When we are working deep in the bone, and especially if the osseous tissue is soft, a sharp scoop (Fig. 44) or the chisel without the hammer should be employed. If the cortex be very thin, as in the child, the pressure of the curved chisel with the hand may be sufficient to open the antrum. When, on the other hand, the cortical substance is very thick and hard, or the cells have become partially sclerotic, being converted into an ivory-like substance, it may be very difficult, or even impossible, to reach the antrum, and we must never penetrate further than $\frac{5}{8}$ of an inch from the surface, in case of injuring the facial canal, or the external semicircular canal.

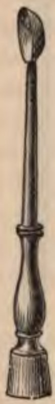

FIG. 44.—The sharp scoop.

The operation, somewhat modified, is sometimes performed for the cure of an already existing carious opening in the mastoid process. In this case a perpendicular incision, from one to one and a half inch in length, is made through the fistular opening in the skin, and the periosteum raised from the neighbourhood of the carious opening. This is widened or scooped out with the curved chisel or sharp spoon, and, if any piece of loose necrosed bone is found, it should be removed. Sometimes we find a long narrow canal perforating thick sclerosed bone; we should, with great caution, widen it in the direction of the antrum.

When we reach the mastoid cells, a careful examination should be made of their interior. We may find purulent or caseous collections, cholesteatomatous masses, osseous debris, granulations or connective tissue formation. A cautious endeavour should be made to force a stream of a warm weak solution of salt through the opening, with the object of passing the current through the antrum, tympanum and external auditory canal, or Eustachian tube. This may, at first, be impossible, owing to the presence of granulations, connective tissue formations, hardened masses, &c., and it is well, at first, only to employ slight force, for otherwise pain in the head, tinnitus, giddiness, or even fainting may be excited. Usually, however, after two or three days, if we do not succeed at first, a free communication is established between the artificial opening and the external auditory canal. A drainage tube should be kept in the opening for some time. The patient must be kept at perfect rest for a week after the operation. The experience of Schwartze shows that the risk to life is very slight, the mortality due to the operation being, in his cases, about one in fifty.

For weeks, and even months, careful and regular cleansing and disinfecting treatment may be required. A watery solution of carbolic acid, or boracic acid, should be injected twice a day through the opening into the external auditory canal, and *vice versa*. Granulations, or roughened bone, must be scraped away with the sharp spoon, or destroyed with the galvanic cautery, and powdered boracic acid or iodoform applied. To prevent the orifice in the bone contracting, a leaden pin, or tube with lateral aperture, must be kept in the opening. Long-continued patient treatment is usually necessary; in fifty of Schwartze's cases the duration of treatment extended from one month to two years. In seventy per cent. of his cases there was ultimate recovery.

Occasionally, though somewhat rarely, there is a localized collection of matter in the lower part of the mastoid process; in such a case the osseous shell must be perforated at the seat of the collection.

In regard to the indications for this operation, it must be remembered, that we have rarely conclusive evidence of the existence in the mastoid cells of retained pus or secretion. While, on the one hand, there may be purulent or caseous collections, and even necrosed bone, without either subjective or objective symptoms, on the other hand there may be severe inflammatory phenomena, and yet no purulent accumulation may be found. If in the course of chronic purulent inflammation of the middle ear, dangerous symptoms arise either of a pyrexial nature or such as to arouse the suspicion of extension of the disease to the intra-cranial parts, and when pain, with or without redness and swelling, exists in the mastoid process, we should, before operating, explain to the patient or friends that the result is uncertain —that the disease may have already extended to vital parts. With no evidence of mastoid inflammation, no tenderness of the mastoid region whatever on percussion or pressure, and pretty clear evidence that the dura mater, brain, or venous channels have become involved, we are not justified in performing an operation, which appears formidable to the friends of the patient, with little or no chance of benefit.

It has been observed that, although the mastoid cells have not been opened into, only a portion of the cortex being removed, apparent advantage has attended the operation. Politzer suggests that a small wedge of bone, ¼ of an inch in extent, might be removed without penetrating to the antrum, as a means of curing those obstinate suppurations of the ear, which have resisted every other method of treatment. Considering how frequently perforation of the mastoid cells, occurring either spontaneously or artificially, puts an end to a suppurative disease of the middle ear, attended even by caries of the inner wall of the tympanum which has existed for many years unaffected by treatment, it is a question whether, in certain cases, we should not resort to this operation as a means of curing such cases, although no inflammatory symptoms or evidence of retained pus in the mastoid cells exist.

We may say, in conclusion, that this operation is of great value, 1st, in averting the imminent danger to life of acute purulent collection in the mastoid cells; 2nd, in bringing about the cure of caries of the mastoid and even of the petrous part of the temporal bone; 3rd, in curing chronic suppurative disease of the middle ear, which has resisted every other mode of treatment; 4th, in preventing or curing (Schwartze) anæmic, cachectic, or even tubercular conditions, by removing the caseous accumulations, which, by their absorption, might give rise to tubercular self-infection (see Part Third, Chapter IV.).

XII.—Hygienic Treatment.

When there is a predisposition to ear disease, or when some form already exists in the individual, precautions should, if possible, be taken against loud noises, sudden or constant; against colds in the head, or against the direct action of cold water or cold air upon the ear. Cold water, especially salt water, must never be allowed to pass into the ear. Even in ordinary washing, the ears should be plugged with cotton, to avoid the trickling of water into the ear. In diving, or in the use of the shower-bath or of the head douche, the precautions should be still more minute. The cotton plugs should be soaked in pure almond oil, or the India rubber ear-protector recommended by Dr. Cousins* may be employed. In sea-bathing a waterproof cap should be used in addition to the plugs in the ear. There is probably no popular delusion more common than that splashing or laving cold water upon the ears and sides of the head strengthens the organs. The fact is, the ear is very intolerant of cold, especially in persons who have a hereditary tendency to ear disease, or in whom an ear disease already exists. If the patient be exposed, as in travelling in an open vehicle, to cold wind, especially if accompanied by rain, sleet, or snow, the ears should be carefully protected by a cotton or wool plug, or by a suitable head wrapping. Catarrh, or inflammation of the ear, frequently originates in such kinds of exposure. Of course during mild summer weather, or even in winter if there is no wind, plugging or wrapping up the ear is not desirable, and should not be practised.

Such persons should also be careful in taking quinine or salicine. If possible, these medicines are to be avoided when an ear disease already exists.

During and immediately after the exanthematous diseases attention should be given to the state of the ear, and, if necessary, prompt treatment employed. In view of the not infrequent absence of subjective symptoms, in an acute inflammation of the middle ear occurring during one of the exanthemata, and the serious consequences which may ensue from this disease, it is very desirable that medical men should occasionally inspect the ear during the course of those diseases, which are known to be frequently attended by aural complication, and that they should, on leaving off attendance upon such a case, instruct the patient or friends to report if any symptom, such as a discharge from the ear, should show itself. Timely treatment is of very great importance, and might prevent great mischief to the organ.

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* See *British Medical Journal*, 31st Dec., 1881.

Patients are also to be advised against irritating the ear, either by hard pointed objects, unnecessary or improper syringing, or by the indiscriminate pouring of liquids into the ear.

The purity of the air, the cleanliness of the skin, the suitability of the diet, and the healthfulness of the whole surroundings, have an influence on the progress, especially of chronic disease of the ear. The purity of the air breathed by the patient while sleeping, and an absence of dampness and smoke, are of great importance. The impure air breathed in schoolrooms, offices, workshops, in some instances loaded with mechanical or chemical irritants, is very likely to maintain catarrhal processes in the nose, throat, and middle ear. Out-door exercise in suitable weather, and with proper precautions, especially if the air is not only pure and fresh but also dry, conduces to a healthy state of these mucous membranes.

Baths of warm or luke-warm salt water, repeated every second day, have often a useful effect upon the catarrhal process in the ear, when thorough friction of the skin is employed after each bath. Sea-bathing or cold-water bathing is sometimes beneficial in chronic dry catarrh, where every precaution is adopted to keep the water out of the ear. Judiciously employed, they protect the system against catarrhal attacks; but if the dulness of hearing or the *tinnitus* become aggravated, the bathing must be abandoned.

In some cases of muco-serous catarrh, when local treatment proves unsuccessful, a residence of two or three months in the country, especially in a mountain or upland district, has proved most satisfactory in maintaining a permanent state of improvement. In all cases a change of air from town to country is a powerful aid to local treatment. In chronic dry catarrh, while change of air has not usually so beneficial an influence upon the ear, it is very often advantageous, especially with children. A mild, dry, equable climate acts probably by diminishing the tendency to nasal and pharyngeal catarrh.

Excessive use of tobacco or alcoholic drink exercises a very deleterious influence in inflammatory or catarrhal affections, not only inducing a hyperæmic condition of the ear, but also tending to produce a state of chronic pharyngitis. These luxuries must therefore be employed in very great moderation.

For further information as to the direction in which measures should be employed for the prevention of ear disease, the student is referred to the chapter on causation.

PART SECOND.

DISEASES OF THE PARTS OF THE EAR COVERED BY SKIN.

Chapter I.—The Auricle.
Chapter II.—The External Auditory Canal.
Chapter III.—The Tympanic Membrane.

CLASSIFICATION OF DISEASES.

THE Diseases of the Ear fall naturally into three groups.

1st, Those which primarily or mainly affect the parts of the ear covered by *skin*, namely, the auricle, external auditory canal and tympanic membrane.

2nd, Those which primarily or mainly affect the parts of the ear lined by *mucous membrane*, namely, the tympanum, Eustachian tube and mastoid cells.

3rd, Those which primarily or mainly affect the auditory nerve and labyrinth—complex structures of nerve, membrane, and bone, with a watery fluid.

1st Group.—The diseases forming this group possess the following characteristics:—1. They affect parts covered with skin, which is comparatively thick over the external portions, but gradually diminishes in thickness as it passes inwards, until over the tympanic membrane it is extremely thin. The tympanic membrane, separating the external auditory canal from the cavity of the tympanum, is a structure common to both; but the diseases which primarily affect it, as well as the injuries to which it is liable, fall more properly under the 1st group 2. They are in most cases similar in their pathological nature to diseases of the skin elsewhere, although in their clinical and therapeutic aspects they are modified by the position, form and function of the organ involved. 3. They are generally caused by influences coming from without. 4. They are accessible both to examination and treatment chiefly from the outside.

2nd Group.—These diseases possess the following characteristics:—1. They affect parts having a continuous lining of mucous membrane, thick at its commencement, where it is continuous with the pharynx, but becoming extremely delicate in the mastoid cells. 2. They are in their pathological nature similar to the catarrhs or inflammations of mucous membrane in other parts of the body, but modified in their consequences by the complicated form, the relations, and great delicacy of this organ of sense. 3. They are caused mainly by injurious influences acting from the nose and throat. 4. Much of their treatment is applied from the nasal passages and pharynx.

3rd Group.—The diseases of this group have the following points in common:—1. They affect neither mucous membrane nor skin; but certain complex structures of nerve, membrane, and bone. 2. They are pathologically ill defined and almost incapable of precise recognition during life. 3. They are caused mainly by influences acting from the middle ear or from changes in the circulation. 4. They seldom yield completely to treatment.

CHAPTER I.

THE AURICLE.

ANATOMICAL AND PHYSIOLOGICAL DESCRIPTION.

THE *auricle* or *pinna* (Fig. 45) is that part of the ear, which projects from the side of the head. It is composed of a framework of yellow elastic fibro-cartilage covered with perichondrium and skin. In the lower or most dependent portion—the lobule—the cartilaginous tissue is absent, there being here fat and connective tissue in its place. The auricle becomes much more soft and flaccid in advanced years. The skin, especially in the concavities, is richly supplied with sebaceous glands and hair follicles. The outer or anterior aspect presents concavities and eminences, which have received distinctive names. The posterior and upper edge folded inwards is termed the helix but in many persons instead of being folded, it is partially or wholly flat, and frequently a projection, more or less marked, is seen at the upper part, and is looked upon as a homologue of the pointed ears of the lower animals

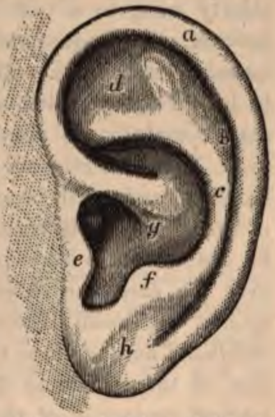

FIG. 45.—Auricle—*a*, helix; *b*, fossa of the helix; *c*, antihelix; *d*, fossa of the antihelix; *e*, tragus; *f*, antitragus; *g*, concha; *h*, lobule.

(Darwin). The ridge, forked at the upper end, in front of the helix, is named the antihelix. Between these two is the fossa of the helix or fossa navicularis. The concave space enclosed by the forked upper terminations of the antihelix is termed the fossa of the antihelix or fossa triangularis. The lower prominent extremity of the antihelix is called the antitragus. The large, deep concavity in front of the ridge of the antihelix is the concha, divided into two parts by the commencement of the ridge of the helix. The concha passes into the external canal of the ear. In front of and overlapping the external opening of the ear is the nipple-shaped projection of the tragus, whose inner surface often gives rise, especially in elderly men, to a tuft of bristly stiff hair. The notch between the tragus and the antitragus is termed the incisura intertragica. The auricle presents great varieties in length and breadth, as well as in the inequalities on its surface and in the size of its angle of attachment to the head. These varieties are connected partly with family peculiarities, partly with peculiarities of race, partly with habits of dress, and partly with the effects of disease. In women, for example, who have for years worn caps closely applied over the ears, the auricle may often be seen lying flat against the head. Intertrigo of the back of the ear in childhood may produce the same abnormally close application of the auricle to the side of the head. Again, the marked projection of the ear from the side of the head, so striking a peculiarity in some men, is occasionally due to, or at least aggravated by, the common habit of boys wearing their caps closely pulled down between the auricle and the head. The form of the lobule of the ear is often sadly marred by the constant traction exercised by heavy ornaments suspended from this part of the ear.

The auricle is furnished with so-called extrinsic and intrinsic muscles—three of the former and seven of the latter; but these are extremely rudimentary in man, and hence the auricle is usually capable of only a very limited amount of movement. This part of the ear does not seem to contribute materially to the power of hearing. It has been repeatedly observed that the loss of an auricle had little if any effect upon the acuteness of hearing, and we may therefore look upon it merely as the homologue of the more highly developed and more useful organ of the lower animals. Probably, however, the different concavities, especially the concha, by collecting the waves of sound and reflecting them into the external auditory canal, aid somewhat in the transmission of sound to the deep parts and in increasing the perception of it. The hollow formed by the inner surface of the tragus must be of use in guiding the waves of sound, which have been collected and reflected by the concha, into the external auditory canal (Politzer). By some writers the auricle is thought to act as a resonator for high tones.

DISEASES OF THE AURICLE.

The proportion of diseases of the auricle coming under the observation of the aural surgeon is much less than that of affections of the other parts of the ear. These diseases will therefore be described with less detail, and will be taken up in the following order:—

1. Injuries.
2. Spontaneous Hæmatoma Auris.
3. Cutaneous Affections.
4. Inflammatory Diseases.
5. Morbid Growths.
6. Congenital Malformations.

1. Injuries.

The auricle from its exposed situation is liable to traumatic injuries, which may be of the nature of incised wounds or contusions.

Incised wounds, on account of the irregularity of the surface of the auricle, should be brought together by means of metallic sutures. An auricle, which has been completely separated from the head, a not uncommon mutilation in Oriental countries, may be made to reunite, if the cut surfaces are rapidly brought into accurate apposition. When permanently severed, an artificial auricle may be substituted for the lost one. A gap in the lobule—cleft lobule—is not unfrequently seen as a result of the wearing of ear-rings. Either by the mere weight of a heavy ornament, or by violence, the lobule is torn through, and a cleft is formed, when the two separated edges of the wound have cicatrized. This deformity is easily rectified by carefully pairing the edges, and accurately bringing them together by sutures.

Contusions often lead to important results, especially if, in consequence of previous disease, the cartilaginous tissue has been weakened and has on that account been ruptured by the injury. In this way the condition named "Hæmatoma auris" or "Othæmatoma" may have a traumatic origin. The blood effused into the tissue, usually between the perichondrium and the cartilage, forms a sanguineous swelling at the upper and anterior part. At first this swelling has generally a dark reddish blue appearance, but it may have the natural colour of the skin (Fig. 46), and there is considerable pain and a feeling of tension. After a time, if the effused blood is imperfectly absorbed, organization of the contents of the swelling takes place with thickening of the surrounding tissues, followed ultimately by contraction. The normal ridges and concavities become in this way partially or wholly effaced, and, in the course of time, the auricle may be converted into a shrunken, shapeless mass—the so-called shrunken ear (Fig. 47). The most serious deformity ensues, when the cartilage has been torn by the injury. This deformity is not unfrequently seen in professional boxers.

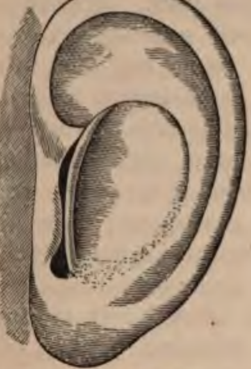

FIG. 46.—Hæmatoma auris—early stage.

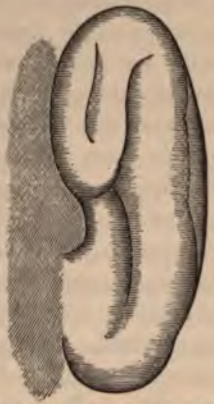

FIG. 47.—"Shrunken ear" resulting from hæmatoma auris.

2. Spontaneous Hæmatoma Auris.

But hæmatoma auris may arise without a traumatic cause. The swelling may be developed spontaneously and very quickly, so that in a few hours it may attain the size of a walnut. Here there is less pain and less tendency to serious deformity than in those cases, which have a traumatic origin. The insane seem specially liable to this sanguineous swelling, although it may also occur spontaneously in persons of sound mind. By some it is contended that even in the insane its origin is always traumatic. Its association chiefly with such forms of insanity as acute mania and general paralysis, where there is greater liability to injury, inflicted either by the patients themselves or by attendants, and its preference for the left ear, are the most important facts adduced in favour of this view. Specialists on insanity are now, however, pretty generally agreed that, while hæmatoma auris in the insane may arise from an injury, and that a slight one, its occurrence without any traumatic cause whatever is indisputable. There seems to be therefore in the insane some special tendency to this effusion of blood in the tissue of the auricle with the consequent shrinking, and the predisposing cause is probably some morbid change in the cartilaginous tissue and blood-vessels. The former has previously become softened or degenerated. In the ear not affected with the tumour we sometimes find nodulated, thickened portions of cartilage. The walls of the vessels have also become weaker from the softening process in the cartilage, so that slight causes, as a gentle blow, pressure, or even the hyperæmia of mental emotion, may produce a rupture. Some writers suggest the probability of a connection existing in the insane between the circulation in the brain and that in the ear as accounting for these effusions of blood. If the "shrunken ear" come under observation, it is well to inquire into the past history of the patient, especially as to the question of insanity.

The *treatment* of hæmatoma auris, when traumatic in origin, should consist, at the early stage, in the use of cold moist applications with moderate pressure. Afterwards we should employ remedies to promote absorption or to counteract inflammatory reaction. If pain be very severe and the swelling remain undiminished after some time, it should be punctured or even incised and the contents removed.

3. Cutaneous Affections.

Eczema of the auricle. This is the most frequent affection of the auricle which comes before the surgeon. As in other parts of the body, it may occur in the *acute* or in the *chronic* form.

The *acute* form manifests itself by great redness and swelling, with a sense of heat and tension. As a result of the swelling the organ appears to project abnormally from the head. The disease may at this stage be mistaken for erysipelas. After a short time a more or less extensive crop of vesicles appears, from which there soon begins to exude a reddish yellow fluid, sometimes containing blood; or the exudation may take place without the formation of vesicles. This fluid, by drying, forms crusts or scabs, which cover the cutis now denuded of its epidermis. The disease may be attended by more or less febrile disturbance.

The *chronic* form of eczema is met with much more frequently than the acute. It is often a part of, or an extension from, an eczematous condition affecting the face and scalp. It may involve the whole of the auricle, but more frequently it is limited to individual parts. It is, for example, not uncommonly met with in the lobule, originating perhaps from "boring the ear." Behind and above the auricle at its attachment to the head is also a common situation for the disease to appear either as a red moistened surface, or as fissures having a red and moist basis denuded of epidermis. It also frequently attacks the fossa of the helix. In the most chronic form there is often very considerable infiltration of the skin, which is yellowish brown, reddened, and covered either with inspissated secretion or with numerous epidermic scales. There are also frequently fissures, out of which fluid exudes, and which are apt to bleed. Great itchiness is now the predominant feeling. Acute exacerbations, however, may take place, when besides the itchiness there is a painful sense of heat and tension. When this condition of chronic eczema is allowed to go on without treatment, which is too frequently the case, especially among the humbler classes, the normal configuration of the auricle may be transformed into a thick brownish-red shapeless mass covered with crusts and scabs or marked with fissures. There is frequently also considerable loss of hearing from the induration and thickening of the skin at the outer opening of the external auditory canal.

The *treatment* of acute eczema consists in protecting the ear against pressure, and at the same time excluding the atmosphere by dusting the part with a fine powder, such as finely powdered starch (f. 31). A solution of acetate of lead is also very useful, alleviating the sense of heat and probably shortening the acute stage (f. 9). The diachylon ointment is also a very useful application after the first few days (f. 18). A purgative (f. 108 to 110) may be prescribed, and only light diet should be permitted.

The treatment of chronic eczema, in order to be successful, should be continued for a long time, and the topical applications require to be varied repeatedly. We should be careful to treat the neighbouring parts of the head, if they are also affected, and we must prevent hairs getting into the moist cracks, and so irritating them. Applications of an astringent and stimulating nature are most suitable. We must be careful, however, in the event of an acute exacerbation attended by great heat and pain, to abstain from stimulating remedies, and must resort to the soothing means recommended for acute eczema. The auricle should be protected by a light and soft covering made for the purpose, so as to avoid the contact of dirt or exposure to injurious pressure. When there is a great tendency to the formation of crusts the milder stimulating and astringent applications are to be used, such as the diachylon ointment (f. 18) or benzoated oxide of zinc (f. 19). It is useful also at the same time occasionally to bathe the parts with the solution of acetate of lead. If the scabs are very difficult to remove, they should be frequently saturated with almond oil, and then light warm poultices of bread crumbs applied. If there be great induration, infiltration, or epidermic formation, applications of a more distinctly stimulating character must be used; and for this purpose tarry and mercurial preparations are most useful. Formulæ Nos. 17 and 19 are mild stimulating ointments, with which we may begin. When there are great scaliness and dryness with itchiness, either of the formulæ Nos. 16, 20, and 24, may be employed. It is to be remembered that the presence of moisture and heat in the skin necessitates caution in the use of stimulating substances. In scaly eczema of a very chronic character, mainly affecting the entrance to the external auditory canal, painting with a strong solution of nitrate of silver (f. 44) two or three times is very beneficial.

Internal remedies are frequently necessary in the treatment of chronic eczema, especially of the scaly variety. Arsenic and iron are the most important of these, and their use should be continued for a considerable time (f. 95). If we have to deal with a scrofulous patient, cod liver oil should be given in addition to the iron or arsenic. Frequent exposure to the fresh open air of the country, and nutritious food are here, as in all chronic diseases, very helpful in bringing about a cure.

Herpes Zoster or *Shingles* occasionally affects the auricle. In its distribution the eruption corresponds either with the auriculo-temporal branch of the trigeminus or with the great auricular branch of the first cervical nerve. Some persons are periodically affected with herpes zoster on the auricle. It is usually attended with severe neuralgic pains.

Erysipelas frequently extends from the face to the auricle, although it rarely affects this part primarily. The swollen œdematous and reddened appearance may possibly be mistaken for the early stage of acute eczema, especially as vesication may appear in erysipelas. The nature of the case is clear, when we find, as is usually the case, that it simply forms a part of an erysipelas of the face and head.

Lupus occasionally attacks the auricle either in the form of lupus vulgaris or lupus erythematodes, the former sometimes producing serious deformity and partial adhesion of the auricle to the side of the head. In the symptoms and treatment there is no essential difference between this disease, when it affects the auricle, and when it attacks other parts of the body. The student is therefore referred to works on dermatology for further information. Comedones, seborrhœa, erythema, and other skin affections are sometimes to be found on the auricle, but their situation here invests them with no special claim for further consideration.

4. Inflammatory Affections.

Under the influence of intense cold, especially in persons having a feeble circulation, the auricle may be frostbitten, and in this way even completely destroyed. In milder cases the part affected simply appears red and inflamed; in more severe forms there may be small livid nodules, which become pale on pressure with the finger. Vesicles or ulcerations are occasionally seen. The treatment of frostbite consists in local application of iced water or gentle friction so as to restore the circulation. The nodules should be painted with the tincture of iodine or with collodion. The results of the inflammation must be treated on ordinary surgical principles.

Inflammation of the skin of the auricle, either of the diffuse or the circumscribed variety (furunculus), may occur independently of the preceding affections. In this case it is either part of a like process in the external auditory canal, or the result of improper poulticing of the ear. The lead lotion should be employed for the diffuse form; and for the furuncular variety the treatment to be described for the same disease, when occurring in the external auditory canal, will suffice. Perichondritis of the auricle is seldom seen. It appears as a red, fluctuating swelling, containing serous or purulent fluid, and generally occupying the fossæ of the concha and helix. The swelling should be opened by a free incision, and pressure applied. Examination with a probe through the opening will detect bare, uneven cartilaginous tissue. Complete recovery of the part usually takes place.

5. Morbid Growths.

Various kinds of morbid growths, simple and malignant, are occasionally met with on the auricle. Epithelioma is a very rare affection, and, as in other parts of the body, is to be treated by extirpation.

Fibrous growths of the lobule, and hypertrophy of the lobule, when they do occur, have probably in most cases their origin in the irritation produced by the insertion or wearing of earrings. Vascular tumours, as angioma and nævus, are rarely met with. Sebaceous cysts have occasionally their seat on this part of the body. Morbid growths affecting the auricle are, however, more frequently seen and treated by the general surgeon than by aural specialists. Their detailed description would consume more space than accords with the purpose of this book, and the student is therefore referred to treatises on general surgery for accounts of these rare conditions of the auricle.

6. Congenital Malformations.

The auricle may suffer congenitally from excess or defect of formation or from abnormal position. Complete supernumerary auricles have been only very rarely met with. Not unfrequently, however, one or two cartilaginous or cutaneous protuberances are seen in front of the tragus, and these appendages to the auricle are looked upon as very rudimentary additional auricles. Defective formation or development is occasionally observed, although complete absence of the auricle is very rare, for there usually exists some rudiment of the organ, however imperfect in size or formation. Sometimes it is represented by a cartilaginous ridge, at others by a small cartilaginous or cutaneous projection. In the marked forms the defective development of the auricle is generally associated with a defective condition of the external auditory canal, which may consist of a fine canal terminating in a blind extremity. The tympanic ring is usually absent, while the tympanum and even the labyrinth frequently share in the malformation. Cases are, however, known where an extremely rudimentary condition of the auricle existed with quite a normal state of the other parts of the organ. Anomalies of formation of the auricle seem to be often attended by some abnormal state of the palate and maxillary bones, and this subject was fully discussed in a paper by Professor Allen Thomson in the *Edinburgh Journal of Medical Science* for April, 1847. If the sentient part of the ear is not seriously impaired, a certain amount of hearing is compatible with defect or absence of the auricle and of the external auditory canal. The writer had the opportunity, through the kindness of Dr. H. C. Cameron, of making an examination of a child, in whom there were only the most rudimentary auricles, with complete absence of the external auditory canals, and he was convinced, both from his own observations and the statements of the mother, that an appreciable amount of hearing was possessed by the child. Professor Allen Thomson, in the paper just referred to, relates the cases of several persons with congenital closure of the external auditory canals, who were capable of hearing speech in a moderately loud voice.

As a rule operative interference, having for its object the artificial formation of a passage for the waves of sound, is not attended by any benefit. In cutting down into the small *cul de sac* representing the external auditory canal we usually come upon bone showing an osseous closure farther in. An exploratory incision, however, might be tried and could do no harm.

CHAPTER II.

THE EXTERNAL AUDITORY CANAL.

ANATOMICAL AND PHYSIOLOGICAL DESCRIPTION.

THE *external auditory canal* (Fig. 48) is a somewhat winding tube, about an inch long, extending from the auricle to the tympanic membrane which separates the canal from the cavity of the tympanum. In the adult its walls consist partly of bone and partly of cartilage. The osseous part of the canal forms the inner two-thirds. The outer third is

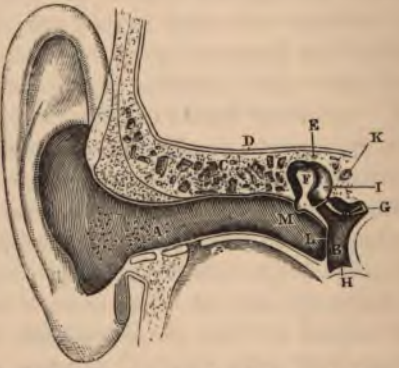

FIG. 48.—Vertical section of the external auditory canal, tympanic membrane, and tympanic cavity (right ear): A, ceruminous glands in the external auditory canal; B, tympanic cavity; C, cellular spaces in the roof of the canal; D, dura mater lining upper surface of roof of canal; E, roof of tympanic cavity; F, head of the malleus; G, foot-piece of stapes; H, floor of tympanic cavity; I, body of incus; K, Fallopian canal; L, tympanic membrane; M, short process of malleus.

continuous with the cartilage of the auricle; but the cartilage is absent at the upper and back part, where the tube is completed by skin. The cartilaginous part contains several clefts, incisuræ Santorini, which are filled up with fibrous membrane, and it is fixed to the bone by means of fibrous tissue, thus allowing movement of the walls of the canal when the auricle is pulled upon. The width and course of the canal present many varieties. In some persons it is wide and straight, while in others it is narrow and curved. The curvature in the course of the canal is caused mainly by a rounded angle, usually well marked, at the junction of the cartilage and bone in the antero-inferior wall. From this projection the cartilaginous part slopes, in an outward direction, pretty abruptly downwards and forwards, while the osseous portion slopes more gradually downwards, inwards and slightly forwards to the tympanic membrane. Near the membrane the sinking of the floor is sometimes very considerable, this depression being called the *sinus* of the external auditory canal. In consequence of this depression it is often difficult to see the antero-inferior part of the tympanic membrane, while here also small foreign bodies may escape detection, and larger bodies may become very firmly fixed, so as to render their removal difficult. The upper and back walls of the canal are comparatively straight. Two practical considerations follow from the curved direction of the canal. 1st, In introducing the aural speculum, or when syringing the ear, the auricle should be drawn upwards and backwards, so that the angle at the antero-inferior part of the canal may be nearly removed. 2nd, In syringing the ear the point of the instrument should be placed on the upper wall, for, if it be placed on the lower or anterior wall, the stream will probably rebound from the angular projection, and the deep parts will remain untouched.

The lumen of the canal is usually oval in shape; the long diameter has a vertical direction at the entrance, while further in it becomes horizontal, and nearer to the membrane it has an oblique direction from the antero-superior to the postero-inferior surface.

Although the axis of the canal is about an inch in length, the anterior and inferior walls are longer than the posterior and superior. This inequality in length is due to the oblique position of the membrane, which will be afterwards described.

At birth the walls of the external auditory canal consist only of cartilaginous and membranous tissue. After birth the osseous canal gradually develops, and the membranous part gives place in course of time to bone. Behind and above, the osseous canal is formed by the gradual development outwards of the mastoid and squamous sections of the temporal bone; while in front and below, it is formed by new deposition of bone at the annulus tympanicus, which, at birth, is a separate bone to which the tympanic membrane is attached.

In infancy there is very little bulging of the antero-inferior wall of the canal, while, at that time of life, the lower and front walls are twice as long again as the upper and back walls. This is due to the more horizontal position of the membrane in early childhood, when it is almost parallel with the floor of the canal, from which it is separated by an extremely narrow space. This space is filled at birth with epidermic debris, the so-called vermix caseosa. It has been suggested that the infant for a few weeks after birth does not hear (von Tröltsch).

The external auditory canal is lined by a continuation of the general cutaneous covering of the body. The skin lining the cartilaginous part of the canal and a part of the roof of the osseous canal is pretty thick, and contains all the elements of skin, such as sebaceous glands, papillæ, and hairs. At the inner part of the cartilaginous canal are found the glandulæ ceruminosæ, which secrete the cerumen or ear-wax, and which are similar in structure to the sudoriparous glands. The cerumen, which, in the normal condition, consists chiefly of fatty and colouring matter, forms a circular layer of a yellowish white colour and having the consistence of honey at the inner end of the cartilaginous part of the canal. Over the osseous portion of the canal, unless at the roof where a triangular prolongation of thicker skin extends to the membrane, the skin is very much thinner and destitute of glandular elements, but still has fine hairs. It is very firmly adherent to the periosteum, which seems to constitute its deep layer, and is almost inseparable from it. Inflammation of the cutaneous covering of the osseous part of the external auditory canal is therefore more of the nature of a periostitis, and is usually attended by intense pain. Hence also inflammatory affections of this part are attended by risk of caries, necrosis, or hyperostosis in the subjacent bone. It is also to be observed that the lining of the external auditory canal, not being of the nature of a mucous membrane, cannot secrete mucus, and it is not correct to speak of catarrh of this canal. If flakes of mucus are found here, they must have come from the mucous lining of the middle ear, either through a perforation in the membrane, or through a fistulous opening in the osseous wall communicating with the mastoid cells.

The External Auditory Canal has important relations to neighbouring parts (Fig. 49). 1. The parotid gland is situated in front of and below the cartilaginous part of the canal. In abscess of the parotid gland the pus sometimes makes its way through the incisuræ Santorini into the canal of the ear. Tumours or enlargements also of the gland may close or contract the canal by pressure on the anterior and inferior walls. 2. The anterior wall of the osseous part of the canal—the tympanic plate—forms the posterior wall of the articular fossa of the jaw. In injuries to the head, due to a fall from a height, this tympanic plate may be fractured from force applied to the chin. Bleeding from the ear would, in such a case, ensue; but, when due to this cause, would not have the grave meaning usually attached to bleeding from the ear after head injuries. 3. In the young child, the tympanic plate being defective, inflammation of the external auditory canal is apt to pass into the articulation of the jaw and the parotid gland. 4. The

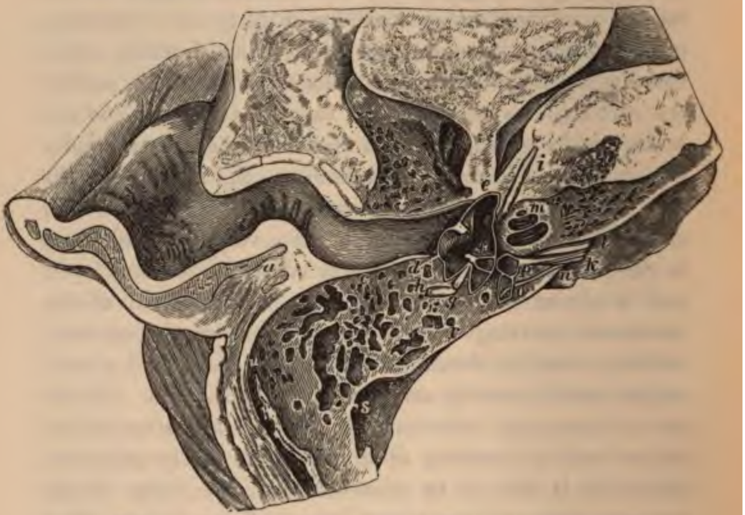

FIG. 49.—Horizontal section through the left organ of hearing, showing the curvature of external canal as seen from above, and relations to neighbouring parts (Rüdinger): *a*, posterior wall of the cartilaginous part of the external canal; *b*, anterior cartilaginous wall corresponding with situation of parotid gland; *c*, the posterior wall of the osseous part of the canal with the mastoid cells behind; *d*, near to the insertion of the tympanic membrane; *t*, anterior osseous wall or tympanic plate. For completed description see Fig. 112.

posterior, and to a less extent the superior wall of the osseous canal, have a close relation to the mastoid cells (Fig. 50). The largest of these cells are separated from the external canal only by a thin plate of bone. Collections of matter in the mastoid cells make their way not unfrequently through this layer of bone by ulceration, and either burrow underneath the cutaneous lining of the canal or burst into the canal of the ear. A fistulous passage between the mastoid cells and the canal of the ear may be formed in this way; and over such an opening exuberant granulations or even polypi may spring up. 5. The upper surface of the roof of the osseous canal forms a part of the floor of the middle fossa of the base of the skull and is covered by dura mater, on which rests the brain. There are records of cases of disease of the external auditory canal proving fatal by extension to these vital parts through the roof of the canal, which is sometimes very thin. The waves of sound, collected and reflected by the auricle, or entering directly into the canal of the ear, are conducted by the column of air in the canal to the tympanic mem-

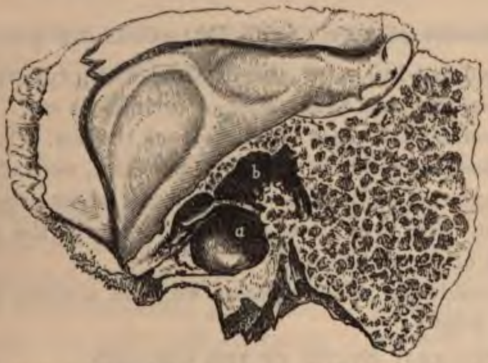

FIG. 50.—Vertical section of right external auditory canal and mastoid process seen from within: *a*, lumen of canal; *b*, antrum mastoideum; *c*, mastoid cells.

brane. The reflection of the waves of sound from the curved walls of the canal probably weaken, in some degree, their strength before they reach the membrane.

DISEASES OF THE EXTERNAL AUDITORY CANAL.

Morbid conditions of the external auditory canal are much less frequent than those of the middle ear. Out of 1088 consecutive cases of diseases of the ear, which the writer has recorded, only 153, or 14 per cent., were affections of the external auditory canal. A much larger proportion, however, yield readily to treatment than in the case of diseases of the middle ear.

In considering these diseases we shall observe the following order :—

1. ABNORMAL STATES OF THE CERUMEN.
    - *A.* DEFICIENCY.
    - *B.* EXCESS.
2. INFLAMMATORY AFFECTIONS.
    - *A.* CIRCUMSCRIBED INFLAMMATION OR FURUNCULUS.
    - *B.* DIFFUSE INFLAMMATION (ACUTE AND CHRONIC).
3. CONSEQUENCES OF THE INFLAMMATORY AFFECTIONS.
    - *A.* THICKENING OF THE CUTANEOUS LINING.
    - *B.* CARIES AND NECROSIS.
    - *C.* COMPLETE STENOSIS OF CANAL.
    - *D.* HYPEROSTOSIS.
4. CONTRACTION OF THE CANAL FROM NON-INFLAMMATORY CAUSES.
    - *A.* EXOSTOSIS.
    - *B.* CONGENITAL CLOSURE.
    - *C.* COLLAPSE FROM ADVANCED YEARS.
5. SYPHILITIC DISEASE.
6. FUNGI.
7. FOREIGN BODIES.
    - *A.* VEGETABLE AND MINERAL.
    - *B.* ANIMAL.

1. Abnormal States of the Cerumen.

The secretion of the ceruminous glands may be deficient in quantity, or it may be excessive.

A. Deficiency of Cerumen.

Causes.—This is often found in persons whose skin is dry and hard—the *glandulæ ceruminosæ* in the cutaneous lining of the external auditory canal sharing in the inactive condition of the sudoriparous glands of the general cutaneous covering. We meet with deficiency of cerumen most frequently in elderly persons, who suffer from deafness due to diseases of the middle ear, especially that condition known as sclerosis of the mucous membrane. The canal of the ear is then found to be dry, destitute of this natural emollient, and also abnormally wide. In these cases the ceruminous glands, after a time, become atrophied, or they even disappear altogether. It must be remembered, however, that the cerumen may be deficient, simply because it is being constantly washed away by purulent discharge, or being removed by the efforts of the patient in picking the ear, or by frequent syringing with water.

Symptoms.—The only symptom of deficiency of cerumen is a feeling of uncomfortable dryness in the ear. As has been said, it often co-exists with impairment of hearing; this, however, is not the *result* of the absence of cerumen. The abnormal dryness of the canal may rather be looked upon as an *indication* of disease in the middle ear.

Treatment.—The sense of dryness in the ear may be relieved by painting the walls with vaseline or glycerine.

This has, of course, no effect upon the hearing. The treatment of the associated disease in the middle ear is sometimes followed by increase in the secretion of cerumen, which may happen even when no beneficial effect is produced in the hearing power of the patient.

B. Excess of Cerumen.

Causes.—This is a much more important condition than the last. It may be due (1st) to an over-active state of the ceruminous glands, or (2nd) to some defect in the natural means of escape of the cerumen from the canal of the ear. Both of these factors may exist in a case of deafness from accumulation of cerumen in the ear.

Increased secretion of cerumen is often found in persons who perspire readily, and who have a plentiful sebaceous secretion. Just as in deficiency of cerumen, so here also the glands of the cutaneous lining of the ear participate in the peculiarities of the glands of the whole integument.

Irritation and congestion of the skin of the canal, temporary or permanent, are the chief local conditions, which seem to excite the glands to abnormal activity. The diffuse or furuncular inflammations and eczematous conditions of the canal of the ear are apt to be followed by excessive formation of cerumen. Mechanical irritation, such as is produced by the frequent use of the point of a pen or toothpick, with the object of relieving a sense of itchiness, or of removing particles of cerumen, has a similar effect. Diseases of the middle ear, and even of the labyrinth, are frequently found associated with excessive formation and inspissation of cerumen; hence, in most cases, the removal of the accumulation is not followed by complete restoration of the hearing power. Roosa is of opinion that "inspissated cerumen is a symptom of an inflammatory affection of the lining membrane of the canal, or of the middle ear, which has extended to the canal." It seems that catarrhal processes in the middle ear have an influence upon the secretion of the ceruminous glands ; but why, in some cases, this influence should produce increase and inspissation of the cerumen, while in others it should act in the direction of diminishing or abolishing the secretion, is not yet clearly understood. Probably, when we are able to differentiate more precisely the varied pathological conditions comprised in the general term of chronic catarrh of the middle ear, a solution of this difficulty will be found.

But, while there may be no actual increase in the secretion of the glands, an accumulation may take place in the canal from some hindrance to the natural escape of the cerumen from the ear. Thus its natural exit may be impeded by a congenitally narrow canal, or, in old persons, by a collapsed condition of the cartilaginous walls, reducing the lumen to a mere slit, or by the presence of abundant bristly hairs at the entrance to the ear. The existence of exostosis, hyperostosis, and eczematous or inflammatory thickening in the walls of the canal, also offer hindrances to the escape of the cerumen, while in those conditions small quantities of cerumen suffice to occlude the canal.

The efforts employed to remove the cerumen from the ear by those, who entertain a fastidious desire to clean the interior of their external auditory canals, are often responsible for bringing about the very condition, which they are employed to avoid. In some, these efforts are limited to the use of a towel every morning after washing, and are sometimes excited by the sense of a drop or two of water getting into the ear. A corner of the towel is screwed into a cylindrical form, and pressed into the ear, pushing before it the cerumen, which is forced into the deep part of the canal. Others use a more elegant instrument, the "aurilave," consisting of a piece of sponge fixed to the end of a small handle. These efforts to clean the ear are unnecessary as well as futile. They generally result in the formation of hard balls of cerumen in the osseous part of the canal, or even in the packing of the secretion upon the tympanic membrane. Ordinary washing of the visible parts of the ear with the fingers will suffice to cause a cleanly appearance in adults whose ears are healthy. If, as is sometimes necessary in young children, the outer part of the canal of the ear requires special cleansing, this should be carefully done by the mother or nurse, while the part is clearly exposed to view, with the corner of a soft towel or sponge, which must be so small as to get behind the material to be wiped away.

Composition of Masses.—The accumulated masses in the ear vary in composition, consistence, and colour. They consist not only of cerumen, but also of sebaceous matter, epidermic scales, and hair, as well as foreign substances deposited from the atmosphere, as coal dust, &c. Not unfrequently a small ball of cotton or some other foreign body occupies the centre of these masses. Their colour and consistence depend very much on the relative proportion of the several constituents. If they are composed to a great extent of laminated masses of epidermis, with an admixture of cerumen and other matters, they have a yellowish or yellowish-brown colour. When, on the other hand, they consist mainly of the products of the ceruminous glands, with some sebaceous matter, the colour is a darker brown, which may sometimes become deep black when there is an admixture of coal dust or other black substance from the atmosphere. The presence of plates of cholestearine imparts at times a shining appearance to the surface of the plug. The consistence of the masses presents great varieties; they may be semifluid, or soft and doughy, or of an almost stony consistence from the complete evaporation of the watery constituents. When the plugs are very old, they often appear as gray, dry masses.

These accumulations may fill the whole external auditory canal from the tympanic membrane to the outer orifice of the ear, or they may be limited to particular parts of the canal. Occasionally there may be only a thin partition at some point in the course of the canal, sufficient, however, to impede the transmission of waves of sound.

Subjective Symptoms.—These masses may go on accumulating during a long period of time, and may have formed in considerable quantities without causing any inconvenience to the patient, or even without his knowledge of their presence, provided that a gap, however slight, exists in the mass, or that no pressure is exercised upon the membrane. On the other hand, as soon as the lumen of the canal is completely occluded, although only by a thin partition, or when even a comparatively small quantity of cerumen has come to press on the tympanic membrane, deafness, frequently accompanied by other unpleasant symptoms, will be manifested.

The deafness may come on quite suddenly, and the patient, on that account, frequently considers that some diseased process has just affected his ear. The collection of cerumen has increased, unknown to the patient, till only a slight cleft remains, when, owing to the entrance of moisture, during washing or in the bath, some swelling of the mass takes place, and the patient is suddenly and to his dismay in a moment affected with deafness. The degree of deafness depends upon the quantity and position of the accumulation, as well as upon the presence or absence of other disease in the ear. It may be such as only slightly to interfere with the hearing of conversation, or it may be so great that, if both ears are affected, the loudest conversation cannot be heard.

For a time the degree of deafness may fluctuate considerably owing to changes in the size and position of the plug. Movements of the jaw, sudden shaking of the head, and the introduction of the finger or some instrument to allay the sense of itchiness may disturb the position of the plug. While at other times the entrance of moisture, or the drying again of previously moist cerumen, may change the size of the obstructing mass, and so account for sudden fluctuations in the hearing. Ultimately, however, when the impaction and the hardening process has been completed, the deafness becomes uniformly severe.

Various kinds and degrees of subjective sounds in the ear (*tinnitus aurium*) may also be experienced by the patient. The most disagreeable buzzing, singing, or rushing noises are complained of, and are sometimes much more annoying than the dulness of hearing. These sounds are also apt to fluctuate in intensity from the same causes as modify the degree of deafness. They are due either (1) to pressure upon the membrane, and thence through the chain of ossicles upon the labyrinthine fluid; or (2) to reflex action upon the acoustic nerve from the irritation caused by pressure upon the branches of the trigeminus and pneumogastric nerves, which impart sensation to the skin of the external auditory canal.

Giddiness, even of a severe kind, may also result from the pressure of the ceruminous masses.* This symptom is produced in the same way as the *tinnitus aurium*, that is, either by pressure on the labyrinthine fluid, or sympathetically through pressure on the nerves of the canal.

Cases are on record in which mental disturbance with marked hallucinations of hearing seemed based upon subjective sounds in the ear caused by the pressure of impacted cerumen, the mental disturbance being permanently cured by the removal of the impacted mass.*

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* See marked example of this described in paper by author entitled, "Importance of a Knowledge of Diseases of the Ear to the Practitioner and Student of Medicine," *Glasgow Medical Journal*, 7th January, 1881.

In only a small number of cases does the patient complain of pain. Occasionally, however, intense pain, radiating from the inside of the ear along the side of the head, is felt. In these cases, probably the pressure of the hard mass has set up inflammation of the lining of the canal, or even of the membrane. A sense of itchiness, with a feeling of fulness or "stopping up," in the canal of the ear is more frequently present than actual pain.

Consequences.—As already mentioned, there are, in many of the cases of accumulated cerumen, other important pathological changes in the ear, such as chronic catarrh of the middle ear or disease of the labyrinth. These are probably frequently part of the same morbid process upon which the excessive quantity of cerumen depends. But the morbid changes found in the ear are without doubt sometimes the direct consequences of the pressure exerted by the plug upon the walls of the canal or upon the tympanic membrane. The lining of the walls of the canal may be inflamed and softened, while the tympanic membrane may be thickened, pressed inwards, and even perforated by the long-continued pressure of masses of cerumen. Cases have been observed in which the canal of the ear has been not only widened, but the posterior osseous wall of the canal scooped out, and at several points perforated, the perforations communicating with the mastoid cells.

Diagnosis.—The diagnosis of excess of cerumen in the ear is generally very easy. By the use of the speculum and reflecting mirror, or even by the unaided vision, the mass is seen to completely or partially occupy the external canal of the ear. It is still necessary to protest against a method of diagnosis employed by some practitioners, namely, to syringe the ear in order to see if any cerumen comes out. Considering the simple and effective means now possessed by the surgeon of examining the interior of the ear, this unscientific practice is quite inexcusable. It is to be noted that the mass may be so packed in upon the membrane as to form a layer on its outer surface which may, if not carefully inspected, be taken for the tympanic membrane itself. Collections of dried purulent masses, coloured with blood or cerumen, masses of fungi or cholestearine may also be confounded with accumulations of cerumen. The preliminary treatment of these conditions, namely, syringing the ear with warm water, being the same as that for excess of cerumen, such mistakes would not likely be followed by injurious consequences.

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* See "Lehrbuch der Ohrenheilkunde," by Dr. A. von Tröltsch, 1877. Page 566.

Prognosis.—In only about a third of the cases of deafness associated with plugs of cerumen in the ear is their removal followed by complete recovery of hearing; in another third we find more or less improvement; while in the remaining third the removal of the plugs has no effect whatever. If a deaf patient, therefore, presents himself for treatment, having his ears plugged with ceruminous masses, we must not at once rashly promise a cure. If the deafness came on suddenly, after washing or after a bath, and if good hearing was enjoyed before, the likelihood is that the excessive secretion is the primary and only affection, and that its removal will completely restore the hearing. If, on the other hand, the deafness has come on more slowly, and if the vibrating tuning-fork, applied to the middle line of the head, is heard most distinctly on the unaffected or better side, the probability is that there is another deep-seated and more serious affection, and that the removal of the cerumen will not be followed by restoration or even by improvement of the hearing. The removal of the obstructing masses is, however, the only sure way of solving the question.

Treatment.—In the removal of ceruminous masses we must trust mainly to the syringe and warm water. If the mass is very hard or firmly adhering to the walls of the canal, it is necessary to use preliminary softening measures before employing the syringe. A solution, consisting of 10 grs. of bicarbonate of soda and a half drachm of glycerine to an ounce of water is more effective than the application of oils. A small quantity of this solution, after being warmed, is poured into the ear and is allowed to remain for from five to ten minutes, this process being repeated several times during twenty-four hours. In cases of extreme hardness of the mass, and when it adheres very tenaciously to the walls of the canal, perhaps through the medium of little hairs, several sittings may be necessary before we are able, with the syringe and warm water, to dislodge and completely remove the accumulation. It is well to point out to the patient that the preliminary process of softening may for the time aggravate the deafness and the noises in the ear, owing to the swelling of the mass from absorption of fluid.

A syringe capable of containing three ounces is of a good size. It may be made either of vulcanite or of brass (Fig. 51). The former is lighter and warmer, but more apt to get out of order. It should be provided with a furrow or

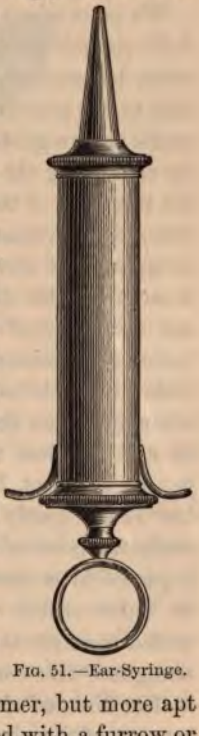

FIG. 51.—Ear-Syringe.

ledge, or two rings to afford a sure catch to the fingers. Considerable injury may be inflicted upon the external auditory canal from the absence of a sufficient catch for the fingers—the point of the syringe being driven into the ear owing to the fingers slipping while the piston is being pressed down. The nozzle of the syringe should be slender but not too long, and it is safer to cover the end with a soft India-rubber tube. If the extremity of the nozzle has the form of a knob, the canal of the ear is apt to be stopped up, and the injected water is thus unable to escape.

We must never use *cold* water in syringing the ear, the fluid should always have a comfortable warmth. If cold water be employed, not only is the effect intensely disagreeable to the patient, but in many persons the syringing will excite severe giddiness and even vomiting. Besides a dish for containing the clean water, another vessel is required for the reception of the water as it escapes from the ear. For this a tin or vulcanite vessel, with a concavity in the edge, in order to fit accurately the uneven surface below the ear, is most suitable (Fig. 52). The comfort of the patient is not unworthy of our attention, and the drenching which patients sometimes undergo, not to mention the trickling of water down the neck and under the collar, must be avoided when syringing the ear. While the vessel for the reception of the fluid is held either by the patient himself, or by an assistant, below the ear, with the concave edge of the vessel gently pressed upon the skin of the cheek and neck, the point of the nozzle or end of the India-rubber tube is placed in contact with the roof of the canal, just within its outer orifice. The auricle must at the same time be pulled upwards and backwards with the left hand, so as to straighten the curve of the canal. The stream of water is then directed along the roof of the canal where the weakest part of the plug is usually found. When the water gets fairly behind the plug its expulsion is quickly achieved. While it is important that all the cerumen should be removed, we must not continue the syringing after the canal of the ear has been emptied. We should therefore examine the interior of the ear in the course of our syringing, so as to stop the operation as soon as we have washed away the whole of the mass.

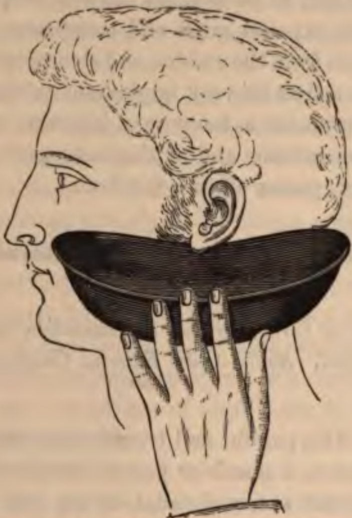

FIG. 52.—Vessel for receiving the fluid from the ear during syringing.

Sometimes we find the plug covered with a dirty white membrane formed of exfoliated epidermis, while an accurate mould of the outer surface of the tympanic membrane may occasionally be seen impressed on the inner end of the expelled mass. In this case we easily trace an elongated indentation marking the situation of the manubrium, while a slight bulging on each side of the indentation indicates the niche on each side of the manubrium.

After the cerumen has been wholly removed, the water should be drained out of the ear, and the canal well dried with cotton. For a day afterwards, a plug of cotton should be worn in the ear, so as to avoid the evil effects of cold air upon the newly exposed canal and membrane, as well as to protect the organ from the sudden and strong effects of sound, which may for a time be very unpleasant to the patient.

Syringing produces a temporary injection of the blood-vessels of the membrane and of the inner part of the canal, which, however, passes off in a few hours.

2. Inflammatory Affections of the External Auditory Canal.

A. Furuncular or Circumscribed Inflammation of the External Auditory Canal. Syn.—Otitis Externa Circumscripta; Boils in the Ear.

Pathology.—This painful and troublesome affection has its origin and seat in a gland or hair follicle in the subcutaneous tissue of the external canal of the ear. Like furuncular inflammation in any other part of the body, a boil in the ear is attended by the formation of a core, composed of sloughed connective tissue or of a necrosed follicle or gland, around which there is usually more or less purulent formation. An abscess, not of the nature of a furuncle, may form in the subcutaneous tissue of the external auditory canal.

The disease does not often terminate with a single boil; we generally find a succession of them, and that, while one is passing away, another begins to manifest itself. We may find at the same time boils on other parts of the body, especially on the scalp, eyelids and face.

Causes.—Boils in the ear are found most frequently in adults. Women, particularly at the climacteric period, seem to be more liable to the disease than men. While the disease may affect persons who are otherwise healthy, and even robust, it is commonly met with in those whose general state of health is defective, particularly in those whose digestive functions are badly performed. We may thus meet with the disease in the anæmic woman, or in the *bon vivant.*

Local causes, however, play the most important part in the etiology of the disease. Mechanical irritation, as the use of pointed substances to relieve a feeling of itchiness, may excite the disease. Hence boils are often found where chronic scaly eczema already exists in the cutaneous lining of the external canal of the ear.

The prolonged action of pus or other fluid, such as water or ear lotions, upon the skin of the canal, is a very frequent exciting cause of the disease. For this reason, boils in the ear are a common complication of chronic purulent diseases of the middle ear. Solutions of alum seem to be especially liable to set up the disease.

The action of cold air or cold water, or of chemical irritants, may also produce furuncular inflammation; but these causes are more likely to excite the diffuse form of inflammation.

Recently, Dr. Löwenberg, of Paris,* stimulated to the inquiry by the discoveries of M. Pasteur, has made important researches into the parasitic origin of furunculi in the ear, as well as in other parts of the body. His investigations, and especially his discovery of micro-organisms in the contents of the boils, have satisfied him that the disease is always due to the invasion and multiplication of a special microbe, belonging to the family of the micrococci. The parasite is derived from either of the two great media, air and water, but especially from the latter, and enters a hair follicle, where it excites the intense inflammation characteristic of a boil. We shall see afterwards how this view of the disease, if accepted, would modify and guide the course of treatment.

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* "Le Furoncle de l'Oreille et la Furonculose." Par Löwenberg —*Le Progrès Médical.* Nos. 27, 29, 30, 32, 33, 34, 36. 1881.

Subjective Symptoms.—The symptoms experienced by the patient are usually pain, impairment of hearing, and subjective sounds in the ear. The degree of their severity depends upon the intensity of the inflammatory process, and upon its situation in the canal of the ear.

If the inflammatory process is mild, and if its seat be at the outer entrance of the ear, the painful symptom in the ear sometimes amounts to only a sense of warmth and fulness, or "stopping up." If, on the other hand, the inflammation is more intense, and especially if it is situated in the deeper parts of the canal, so that the inflammatory area has an osseous basis, the pain is usually intensely acute.

Patients often describe it as that of a painful sense of stretching, and a distracting beating or "hammering in the ear," worse at night, with occasional intermissions of an hour or two. A sharp pain also frequently radiates over the side of the head, and I have not unfrequently found the patient complain of a particularly painful spot on the parietal protuberance of the affected side. The pain in the ear is aggravated during chewing or speaking, or any other movement of the lower jaw, this being due to the close relationship between the canal of the ear and the articulation of the lower jaw. Pulling the auricle of the affected side, or lying upon it, also aggravates the pain, while incautious attempts to introduce a speculum cause intolerable suffering. The tragus is often especially tender to touch.

In some cases, and particularly when the furunculus is situated on the posterior wall of the osseous part of the canal, the soft parts over the mastoid process may be red, œdematous, and very painful on pressure, and the auricle juts out somewhat from the head, symptoms thus simulating, in their intensity, periostitis of the mastoid process.

The degree of impairment of hearing depends upon the extent of the occlusion of the canal by the disease, or upon the amount of concomitant hyperæmia of the middle and even of the inner ear. The tinnitus aurium, when present, is usually of a humming or buzzing character, and is due either to the causes mentioned as producing the deafness, or to the sympathetic relations between the canal of the ear and the labyrinth.

In irritable systems, or in very severe cases, there may be considerable febrile disturbance, even delirium, especially at night.

Objective Symptoms.—In examining the canal of the ear we must use caution and gentleness, simply employing the reflecting mirror until we ascertain the position of the boil; if this is found to be situated in the deep part of the canal, we may then introduce a speculum very gently for a short distance. If a patient complains of the symptoms we have described, the ear speculum must not be introduced before reflecting light into the entrance of the ear, and ascertaining the condition of the canal, for the thoughtless attempt to push a speculum into the external auditory canal, when a boil is at its entrance, will cause the most acute pain.

The most frequent position for the furunculus is in the anterior wall of the cartilaginous section of the canal, where it usually forms a distinct rounded bulging. We may find the colour of the bulging little changed from that of the normal skin, especially at the early stage, when the inflammation is mainly in the tissue under the skin. At a more advanced stage, however, the skin over the furunculus is usually distinctly red. The central part of the tumour is very sensitive, when touched with the point of a probe.

There may be two or even three furunculi found at the same time, but this is rare, as one usually passes away, or nearly so, before another appears.

Course and Consequences.—The disease sometimes passes off without suppuration or rupture. Much more frequently, however, after from three to five days, a reddish, seldom yellowish, spot appears on the surface of the boil where it bursts, giving exit to some drops of thick pus and to a small flaky mass of sloughed tissue. This latter may require to be helped out by gentle pressure on each side with a probe. Immediate relief usually follows the rupture of the boil. The purulent discharge from the boil is generally small in quantity and short in duration, but in certain dyscrasiæ, or where there has been defective treatment, especially the want of proper cleansing, the disease may take a more chronic course. The edges of the opening may then become flabby and undermined, and the opening may exude a thin sanious matter. Only in very rare and exceptional cases, however, does the disease lead to any affection of the underlying bone. It is frequently found that increased formation of epidermic scales and cerumen follows an attack of furuncular inflammation, producing deafness. Hence, it is well that the patient should return for examination a month or two after an attack, so that such an accumulation, if present, may be removed.

Diagnosis.—Furunculi of the ear may be most readily mistaken for the diffuse form of inflammation of the canal. In the former, however, the swelling is more localized, and the pain, as tested by the probe, is limited to a spot at the centre of the swelling. In the diffuse form of inflammation the swelling is uniform and concentric, while there is also usually much more purulent secretion or epidermic exfoliation than in the circumscribed variety of inflammation. A saccular or longish swelling is sometimes found in the upper and back part of the osseous canal, which might be confounded with a furunculus. The swelling referred to is made up of a collection of pus, which has been secreted in the middle ear, and which has burst through the osseous partition separating the mastoid cells from the canal of the ear, forming in this way a collection under the skin of the latter. Here, however, the history of the case enables us to avoid any error of diagnosis.

Prognosis.—The prognosis of this disease is very favourable. It is, however, advisable to warn the patient that several successive boils may form, one immediately after the other, with recurrence, on each occasion, of the painful symptoms, before the disease fully disappears. It is also to be noted that certain persons have regular and periodic recurrence of boils in the ear, at intervals of weeks or months, and extending over a term of years.

Treatment.—We shall consider this under the three heads of (1) preventive measures; (2) remedies to cut short, or to mitigate, the inflammatory process; (3) constitutional treatment.

(1) Causes which are known to excite boils in the ear should, if possible, be removed. If a patient is suffering from a purulent disease of the middle ear, we must use means to prevent the constant saturation of the cutaneous lining of the canal with pus, and avoid the prolonged contact of ear lotions, or the too frequent use of the syringe. The canal of the ear must, in short, be kept as dry as possible. This is best done (*a*) by adopting, as far as possible, the dry treatment of purulent diseases of the ear, instead of the use of lotions; (*b*) by the patient wiping away the purulent secretion from the canal of the ear, by means of absorbent cotton on a cotton holder (Fig. 53), or held by forceps (Fig. 54), as often as is required; and (*c*) by keeping constantly in the ear a cylindrical roll of cotton, of sufficient

size to occupy the greater length of the canal. This cotton plug should be changed as frequently as may be required by the quantity of the secretion. Chronic eczema, or pruritus of the external canal of the ear, if found to exist, should always be removed by appropriate treatment.

(2) At an early stage, the inflammatory process may sometimes be checked and suppuration prevented by the application of caustic, or strongly stimulating substances. Wilde recommended the solid nitrate of silver, or a very strong solution of the same caustic, as being very efficacious. Von Tröltsch, with the same object in view, uses a saturated solution of sulphate of zinc. We rarely, however, see the disease at so early a stage as to give a good chance to these local applications.

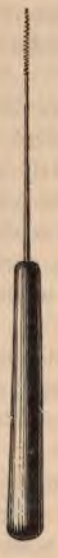

FIG. 53.—Cotton Holder.

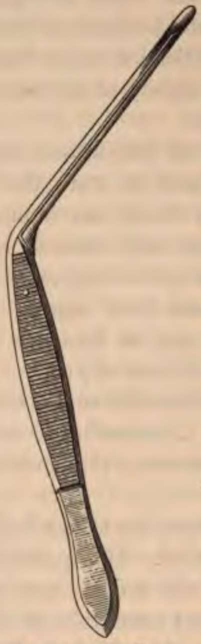

FIG. 54.—Bent Forceps.

The most effective means of cutting short the inflammatory process consists in incising the inflamed tissue. We should not wait till we are sure of suppuration, as, before that stage has been reached, the relief of tension and the free depletion have an excellent effect in relieving the painful symptoms, and in cutting short the inflammatory process. The incision should be deep and free, as the chief seat of the inflammation is underneath the skin. A knife with a slender, curved, and sharp-pointed blade is best suited for making the incision. We should not cut *down* upon the inflamed tissue, but from below upwards, as this is much less painful. Afterwards, gentle pressure should be used on each side of the incision with a probe, in order to press out the contents of the boil from the opening, and then the ear should be syringed with warm water and carefully dried with cotton. Warm poultices of linseed meal, along with occasional syringing with warm water, may be used for a day or so after the incision, but it is to be noted that the sooner we stop the application of moisture to the canal of the ear the less likelihood will there be of a succession of fresh furunculi. It is well, after the warm and moist applications have been stopped, and the canal of the ear carefully dried, to paint the walls of the canal with some unguentous substance, such as vaseline, repeating this occasionally for a few days. In view of the possibly parasitic nature of the disease, the author employs an ointment of vaseline and boracic acid (f. 25), and introduces, at intervals, into the canal of the ear plugs of cotton thoroughly smeared with this ointment. There is little doubt that this has the effect of diminishing the tendency to recurrence of the boils.

If the treatment by incision cannot be carried out, owing to the aversion of the patient to the operation, or if it is not deemed necessary in consequence of the comparative mildness of the disease, we may employ other remedies to relieve the symptoms. Warmth and moisture are extremely useful in relieving the pain and in hastening the process of softening. These may be applied by means of warm linseed meal poultices, or hot fomentations, which should cover the ear and should be frequently renewed. Or, when the lumen of the canal is sufficiently open to allow of the entrance of liquid into the ear, warm water frequently poured into the ear is very soothing to the pain. The sedative effect of the warm water may be increased by dissolving in it some of the muriate of morphia, say one grain of the salt to one drachm of water, of which ten drops, warmed, may be used every two or three hours. An ointment consisting of one grain of the muriate of morphia to a drachm of vaseline, has also a sedative effect, and, if it is successful in allaying the pain, it is to be preferred to the moist applications, for the reasons already mentioned.

If the opening assumes an unhealthy tendency, it should be kept free from secretion by drying with cotton, and we should apply to the part a strong solution of the acetate of lead, which may be repeated a few times, if necessary. If granulations arise, they must be treated with the solid nitrate of silver.

(3) The general treatment of the patient, especially in the recurrent form of the disease, is of importance. If any general disease or evidence of mal-nutrition exist, such as anæmia on the one hand, or plethora on the other, we must employ appropriate medicinal and hygienic treatment. In all cases, we should inquire after and regulate the diet, the hours of rest, the use of stimulants, exercise, baths, &c. The digestive functions are frequently found to be at fault, and are, as a rule, to be corrected by careful attention to regimen as well as by the judicious administration of medicines. Liquor arsenicalis has been recommended as a specific remedy in persistently and periodically recurrent furunculi in the ear. Sulphide of calcium (f. 102) is said to limit or cut short the disease.

B. Diffuse Inflammation of the External Auditory Canal.
Synonym—Otitis Externa Diffusa.

It is convenient to describe this affection under the two aspects of acute and chronic.

1. *Acute Diffuse Inflammation of the External Auditory Canal—Otitis Externa Acuta.*

Pathology.—The inflammatory process extends over the greater part of the cutaneous lining of the canal, generally, indeed, over its whole extent. It usually also involves the outer layer of the tympanic membrane, while there is also some hyperæmia of the middle ear. In the severe forms the periosteum lining the osseous part of the canal participates in the morbid process. The initial stage of hyperæmia commonly advances to free exudation on the surface, or to abundant epidermic exfoliation. Croupous and diphtheritic forms have been observed during epidemics of these diseases; and the membranous deposition, which was found upon the osseous part of the canal, was associated with a similar condition of the pharynx.

Causes.—1. This form of inflammation may originate in an attack of measles or scarlet fever, less frequently of smallpox, erythema, or erysipelas. In these diseases the inflammation is probably propagated from the skin of the face and head to that of the canal of the ear. 2. It sometimes originates in a furunculus, but more frequently in an eczematous condition of the canal or of the auricle, when it is probably excited by the use of hard substances to relieve the itchiness. 3. The direct effect of cold liquid getting access to the ear, as in sea-bathing, or of the trickling of iced water into the ear from iced applications to the head. 4. Direct injury inflicted on the parts, especially the introduction of irritating substances, the unskilful use of injections, the presence of foreign bodies in the ear, or improper or violent attempts to remove them. 5. Causes acting in a reflex way, as cold feet, or the process of dentition especially in children of a scrofulous disposition. 6. Syphilis and masses of fungi excite special forms, which will be afterwards separately considered. The diphtheritic is the rarest form of the disease.

Subjective Symptoms.—The sensations experienced by the patient vary much in different cases. In some they are very slight, being limited to more or less itchiness, heat, and fulness in the ear. In other cases the symptoms, beginning with these sensations, advance to a dull aching in the ear, which in severe forms, and especially when the osseous part of the canal and the membrane are involved, becomes of an intense and penetrating character, radiating from the interior of the ear over the side of the head. The bones of the cheek and the same side of the head are often painful on pressure. The pain is usually aggravated at night, and it is increased by movements of the jaw or by shaking the head as in coughing, as well as by pressing or pulling upon the auricle. Incautious attempts to introduce the speculum are also attended by acute pain. The painful symptoms are much relieved, when the stage of exudation has been reached.

The hearing is impaired in proportion to the amount of swelling of the walls of the canal, the quantity of inflammatory products contained in the canal, and the degree in which the tympanic membrane and cavity of the tympanum participate in the inflammation.

Subjective sounds, particularly a sense of pulsation or buzzing, are generally experienced by the patient, and depend on the same causes which produce the impairment of hearing.

In the more severe forms general malaise, associated sometimes with distinct feverishness, may be present.

Objective Symptoms.—In the early stage the walls of the canal are seen to be hyperæmic and swollen. The hyperæmia is observed chiefly on the osseous walls of the canal adjoining the membrane, especially at the roof and on the upper part of the membrane itself. It is not so visible on the outer part of the canal, partly because the thick epidermic covering conceals the injected vessels in the cutis beneath. In rare cases hæmorrhagic elevations of the epidermis are seen on the floor of the osseous portion of the canal (otitis externa hæmorrhagica). In two or three days a discharge from the ear is seen, and, if the process goes on, we find the canal of the ear occupied either with serous or purulent secretion, which may be partially dried in the form of scabs, or with laminated masses of sodden epidermis mixed with purulent or serous fluid. These laminated masses are thrown off partly from the skin of the canal and partly from the outer layer of the membrane, and sometimes form almost complete casts of the canal and membrane. On account of them and of the swollen condition of the lining of the canal, there is considerable difficulty in getting a view of the deep part of the canal and of the membrane. We should endeavour to remove these accumulations, which is not always easily done, by gentle and cautious syringing with warm water and careful drying. If we succeed in doing so, the walls of the canal, and generally the membrane also, are found to be reddened, swollen, and spongy, while the normal boundary between the walls of the canal and the membrane cannot be distinguished. The cutis, where exposed by recent loss of epidermis, presents a reddish, granular, moist surface; while the tympanic membrane, if much involved in the morbid process, may ulcerate at some point, and a perforation may be the consequence.

Course.—In very slight cases, or when prompt treatment is employed, the inflammatory process may end in resolution before the stage of exudation. Generally, however, it passes on to exudation and exfoliation, after which the morbid process begins to abate, and the discharge from the ear gradually comes to an end in from one to two weeks.

The recovery may, however, be interrupted by one or more exacerbations of the inflammatory process.

Consequences.—When the disease occurs in a person of a strumous or unhealthy constitution, or when treatment is neglected or of an improper kind, the disease lapses into the chronic form, and, as a so-called otorrhœa, may continue for months, or, with occasional remissions or interruptions, for years, or even during a life-time. In these prolonged cases, the disease generally extends into the tympanum, and an otitis media is set up, or a slight thickening of the membrane may remain, causing some permanent impairment of hearing. Exuberant granulations, and even polypi, occasionally spring up in a short time during diffuse inflammation of the canal of the ear.

Diagnosis.—The points which distinguish the diffuse form of inflammation from the furuncular have already been noticed (see p. 190). In some cases it is very difficult to distinguish it from inflammation of the middle ear, if the latter is attended by some swelling of the lining of the inner end of the canal. To distinguish it from the parasitic form the microscope must be employed.

Prognosis.—With proper treatment the prospects of early and complete recovery are very favourable. Even when perforation of the membrane has taken place, it may, under judicious treatment, be quickly healed. Cases arising out of the exanthematous diseases, or those having a traumatic origin, are the most intractable. The former are apt to pass into the chronic stage, because the attention of the physician is bestowed upon the general disease, while the aural condition is ignored.

Treatment.—Local blood-letting (see p. 103) by means of leeches, and the warm water douche are valuable remedies in the early and most painful stage of the disease. The leeches should be applied over the front of the tragus. For an adult two or four are required, while for a young child one is sufficient. The withdrawal of the blood is usually followed by marked relief of the painful symptoms, and probably tends to cut short the disease.

Warm water to the interior of the ear is very soothing. It may be poured in from a spoon while the patient lies on the opposite side, and after remaining in the ear for five minutes it is allowed to run out, when another spoonful is used. This process is continued for half an hour at a time, and should be repeated every three hours. In the intervals the ear should be covered with warm cotton wool. A sponge, which has been pressed out of hot water, applied to the ear is a convenient and soothing application. This should frequently be renewed.

Warm poultices of linseed meal over the ear and side of the head afford great relief and comfort. It is found, however, by experience that their long-continued use tends to produce a softening and ulceration of the deep parts of the ear, especially of the tympanic membrane. Hence the membrane is more likely to be perforated when large poultices are applied and continued constantly day and night for many days. Their indiscriminate use seems also to encourage the growth of exuberant granulations and even polypi in a short space of time. A small warm poultice, conically shaped, introduced into the outer orifice of the ear, is not so likely to be followed by these undesirable results. While, therefore, the large poultices may be applied when the pain is at its height, if the warm water or the small conical poultices do not sufficiently relieve it, we should instruct the patient to stop their use as soon as possible. The occasional instillation of ten drops of the warm solution of morphia (f. 43) may have a more sedative influence than the simple water, but should not be used so frequently.

When the stage of secretion has been reached, the inflammatory products contained in the canal of the ear should be removed by cautious and gentle syringing with warm water. This is very grateful to the patient; but forcible or reckless syringing will not only excite pain, but will probably cause a perforation of the membrane, which has been already softened and weakened by the inflammation.

After syringing, the interior of the ear should be carefully dried by means of absorbent cotton on a cotton holder, and a cylinder of cotton, about an inch long, should be left in the passage of the ear to absorb the moisture and keep the parts dry. This is to be removed, when it becomes saturated with the secretion, and a fresh one applied.

This simple treatment is often sufficient to restore the canal to a healthy state. If, however, the discharge continues for more than a week in spite of all efforts to keep the parts clean and dry, a weak astringent lotion such as four grains of sulphate of zinc to the ounce of water, or one drachm of the strong solution of acetate of lead to four ounces of water, may be employed. The lotion should be applied in the following manner:—After using the syringe and warm water, and then drying the parts carefully, thirty drops of the lotion, *which has been previously warmed*, are poured into the ear and allowed to remain for ten minutes, while the patient lies on the opposite side. This is repeated twice a day, the interior of the ear being dried afterwards on each occasion, and a cylinder of dry cotton introduced and allowed to remain in the canal of the ear. If the discharge is copious, the patient should lie on the affected side when in bed, so as to favour the free escape of the secretion.

In a severe attack, it is very desirable to confine the patient to the house and to limit him to simple diet. A saline purgative at the beginning may also have a good influence on the disease.

2. *Chronic Diffuse Inflammation of the External Auditory Canal—Otitis Externa Chronica.*

Causes.—This disease is generally the consequence of an acute attack. It may arise from disease in the middle ear, especially in the mastoid cells, when, from great swelling and thickening of the lining of the canal, the latter may be almost quite closed. There is sometimes no record of an acute attack, the symptoms having been mild or what may be called chronic from the beginning.

Subjective Symptoms.—These are generally slight. Pain is rarely experienced, unless in the supervention of an acute attack. There is usually a sense of moisture in the ear, and there is more or less deafness with tinnitus, depending upon the degree of implication of the middle ear as well as upon the thickening of the walls of the canal.

Objective Symptoms.—The secretion varies in quantity, from a slight moisture in the ear to an almost continual flow from the outer orifice. It has usually a very disagreeable smell, and has an irritating and excoriating effect on the skin of the auricle and of the side of the neck. There is more or less congestion with swelling or thickening of the lining of the external auditory canal, which, especially at its upper and back part, is often covered with brownish crusts emitting a bad smell. At parts the cutis is softened, as if macerated, and secretes purulent matter. Granulations, or polypi, are sometimes seen springing from the diseased skin. The tympanic membrane is generally thickened, especially in its outer or cutaneous layer, the vessels of which are often injected, particularly at the upper part of the membrane. This thickening of the outer layer of the membrane may conceal the manubrium. There is in some cases excoriation, or even perforation of the tympanic membrane, and occasionally granulations, or small polypi, are met with on its outer surface. We often find glandular enlargements in the neck below the ear, and there may also be more or less swelling of the parotid gland.

Course.—The discharge may cease for a time, especially in warm weather, returning again in cold, damp weather, or from some other exciting cause. Subject to these intermissions the disease may prevail for years and even for a life-time. It frequently extends into the middle ear, producing chronic otitis media, which may continue to exist long after the primary disease in the canal of the ear has passed away.

Consequences.—Chronic otitis externa frequently leads to considerable changes in the canal of the ear or in the neighbouring parts.

1. There may be contraction of the canal from hypertrophy of the cutaneous lining, or from hyperostosis of the osseous walls. Granulations or even polypi may spring from the diseased skin. Caries or necrosis of the osseous part of the external auditory canal is also a sequela of chronic otitis externa.

2. The tympanic membrane always suffers in consequence of this disease. There may be opacity and thickening, or ulceration and perforation, with propagation of the disease to the middle ear. Polypi and granulations on its outer surface are also met with.

3. By extension through the osseous part of the roof of the canal we may have fatal implication of the meninges or brain. Or, by propagation of the disease through the upper and back walls to the mastoid cells and thence to the lateral sinus, death may be the result. Fatal pyæmia has been known to arise from extension of the disease in the canal to the vascular system.

4. The chronic inflammation sometimes extends to the articulation of the lower jaw, especially if gaps exist, as they sometimes do, in the anterior wall, while the parotid gland may be involved through the clefts in the anterior wall of the cartilaginous part of the canal. Some of these consequences will be immediately described more fully, while others will come to be discussed under the head of "Chronic Suppurative Inflammation of the Middle Ear."

Diagnosis.—If a perforation exists in the tympanic membrane and the middle ear is also involved in the chronic suppurative disease, it may be very difficult, if not impossible, to say whether the disease has primarily affected the middle ear or the external auditory canal.

Prognosis.—This is much more uncertain than in the acute form because of the serious complications which may possibly arise. If the disease is limited to the cutaneous lining of the canal, careful and persevering treatment will in most cases be crowned with success.

Treatment.—If an acute attack supervene, the treatment already described for the acute variety of the inflammation must be carried out. The local treatment of the chronic inflammation consists in the use of cleansing, disinfecting, and astringent applications. The secretion must be thoroughly removed by means of the syringe and warm water containing two per cent. of pure carbolic acid (f. 50). The parts should then be properly dried with absorbent cotton, and afterwards an astringent lotion may then be used in the manner already described (see p. 200). The astringent may consist of sulphate of zinc, four grains to an ounce of water, or sulphate of copper in the same strength, or one drachm of strong solution of the acetate of lead to four ounces of water (f. 32, 35, 36). The writer prefers the sulphate of zinc, but it is useful to change from time to time the kind of astringent, especially in very obstinate cases. The insufflation of finely powdered boracic acid with the insufflator (Fig. 55) is also a valuable remedy. If no granulations or polypi are present, and if the secreting process continues after the use of astringent remedies for a few days, a small quantity of this powder should be daily blown into the canal, after thorough cleansing and drying. The proper manner of using these remedies is of great importance. The surgeon should not only give precise directions to the patient or friends, but he should also, once or twice, cause the treatment to be carried out in its details in his own presence. Unsatisfactory results are very frequently due to the ineffective way in which the details of the treatment are carried out. As soon as the secretion ceases to form, the use of lotions must be discontinued, and the parts simply kept dry.

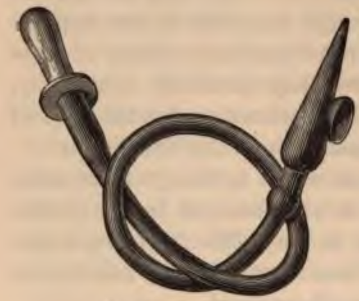
FIG. 55.—Insufflator.

If these applications are insufficient, or when the lining of the walls of the canal is much thickened, a strong solution of nitrate of silver (forty grains to the ounce of water) should be painted over the walls of the canal by the surgeon for a few times, at intervals of three or four days. This has a very beneficial influence upon the thickened secreting cutaneous tissue. Granulations are most effectively and quickly removed by touching them with solid nitrate of silver fused on the point of a probe. This should be repeated several times at intervals of a few days. Strong solution of perchloride of iron applied to the granulations on the point of a probe soon brings about the shrivelling up of these growths.

Polypi are to be removed by means of Wilde's snare with subsequent cauterization of the root. The treatment of aural polypi in general will, however, be considered fully when we take up the subject of chronic purulent inflammation of the middle ear. The treatment of the other complications and consequences of chronic otitis externa will be found under their own proper headings.

Constitutional treatment is useful, when the disease occurs in weakly or strumous persons, although local treatment is always of the first importance. Iron, cod liver oil, nutritious and digestible food, plenty of fresh, open air, &c., have often a determining influence upon the favourable issue of the disease.

3. Consequences of the Inflammatory Affections of the External Auditory Canal.

A. Thickening of the Cutaneous Lining.

The canal of the ear may be from this cause so contracted as scarcely to admit an ordinary probe. Considerable thickening of the skin may be associated with exostosis or hyperostosis. Its most frequent causes are chronic eczema, when it mainly affects the outer part of the canal, or chronic otitis externa, either primary or arising from chronic purulent inflammation of the middle ear.

If there is a discharge from the interior of the ear, gentle syringing with warm water, with subsequent careful drying of the walls of the canal, should be employed, and then a long cylindrical plug of cotton, saturated in a strong solution of nitrate of silver (forty grs. to the oz.), inserted. This plug is allowed to remain in the ear for a few hours, and then removed, when another plug smeared with vaseline is inserted, and changed morning and evening for three days. The plug with nitrate of silver is then applied as before, followed by the vaseline plug. This treatment continued for two or three weeks has usually a very appreciable effect in widening the canal. In the eczematous form of thickening, cotton plugs well smeared with a stimulating ointment, such as f. No. 16, yield satisfactory results. If the canal is not sufficiently widened by such treatment, a thin laminaria or compressed sponge tent should be resorted to. The latter form is preferable, and should not be allowed to remain at first in the ear more than two hours, during which the patient should be close at hand so that the surgeon may himself remove it. At intervals of two or three days such tents may be continued for three or four weeks with excellent effect. The cotton plugs with a stimulating ointment should be worn in the intervals.

B. Caries and Necrosis.

Caries and necrosis of the osseous part of the external auditory canal may be caused not only by chronic otitis externa, but also by chronic purulent inflammation of the middle ear, and especially of the mastoid cells. In the latter case the upper and back parts of the inner end of the osseous canal are most frequently affected.

The subjective symptoms of caries or necrosis are usually those of purulent disease of the external auditory canal, or of the mastoid cells. In caries, however, there is sometimes very severe pain.

The probe is the only certain means of distinguishing caries or necrosis. In the former we feel the softened carious spot, or the probe may pass through a carious aperture into the mastoid cells. In necrosis the rough necrosed bone, firmly attached or loosened, is easily distinguished. Usually at the seat of the diseased bone we find exuberant granulations, which often bleed when touched. These granulations, if removed, immediately form again, and may indeed fill the whole canal. At a carious spot we sometimes find, instead of granulations, a cutaneous ulcer with inflamed edges. In caries due to disease in the mastoid cells the cutaneous and periosteal linings of the walls of the canal, especially of the posterior wall, may be very much swollen or thickened, rendering an examination of the deeper parts of the canal difficult.

In caries of the inner end of the upper wall of the canal the head of the malleus and the body of the incus are sometimes exposed above the upper part of the membrane.

The course is usually a very lengthened one, especially in persons of defective constitutional states. The prognosis is favourable in necrosis, ultimate recovery usually following the separation and removal of a sequestrum. In caries the prognosis is not so favourable, although in children the prospects of recovery are better than in adults.

Treatment.—The otitis externa, or the purulent disease of the middle ear, must be treated, if either exist. In necrosis, after waiting till the sequestrum separates, we should remove it with strong forceps (Fig. 54). A year or more may elapse before the sequestrum can be extracted.

If there be a soft bulging in the upper and back part of the canal, it should be incised, when probably a carious communication with the mastoid cells, or a necrosed part of the canal will be found. In the posterior or anterior wall a carious part may be safely scraped with a small sharp spoon with good effects.

Necrosis or caries is sometimes followed by stenosis of the canal. This must be guarded against by measures suitable for dilating the canal (see p. 205).

C. Stenosis of the External Auditory Canal.

This is occasionally met with, and arises from membranous septa or cicatricial adhesions. These septa, or adhesions may be due to the coalescence of granulations, or polypoid substances, to the long continued contact of an abraded thickened state of the cutaneous lining, or to ulceration from the effects of burns, caustic substances, syphilis, &c. There may be a complete membranous partition, or a septum in the form of a ring with a central aperture, or a considerable extent of neighbouring surfaces may be adherent to one another. The degree of deafness varies according to the thickness of the septa or the breadth of the adhesions. In treating these cases, if we have to deal with a septum, a small portion should be cut out, and a plug worn in the ear for some time afterwards. If there be adhesions of surfaces, careful separation with a fine-bladed knife should be attempted, followed by the use of sponge tents or cotton plugs.

D. *Hyperostosis of the External Auditory Canal.*

This consists in a diffused thickening of the whole extent or a great portion of the osseous part of the external canal of the ear, producing a uniform contraction of its lumen. The bony surface may be smooth, but more frequently it presents small rough elevations. The skin of the canal is generally reddish, and swollen or thickened.

Hyperostosis has usually an inflammatory origin, and is to be looked upon as a chronic periostitis with increased formation of osseous tissue. It is very frequently associated with, or a sequela of, chronic purulent disease of the middle ear. After the removal of a sequestrum from the posterior wall of the canal, a thickening and hypertrophy of the osseous tissue sometimes takes place, which may almost totally close the canal. A similar condition of osseous hypertrophy may exist at the same time in the walls of the tympanum and of the mastoid cells adjacent to the external canal of the ear. Hyperostosis is sometimes, however, found to exist in connection with non-purulent catarrhs of the middle ear. The defective hearing which may exist is frequently due to the presence of secretion in the canal, o to concomitant disease of the middle ear, rather than to the mere thickening of the walls. The contraction of the lumen of the canal, caused by the uniform thickening of the osseous walls, may lead to serious consequences in cases where purulent disease of the middle ear also exists. If the contraction becomes so extreme as to prevent the escape of purulent secretion from the middle ear, fatal retention of pus may ensue. Cases are on record where perforation of the mastoid process had to be performed in order to save the life of the patient (Schwartze).

Hyperostosis is distinguished from exostosis by the distinctly circumscribed form of the latter as compared with the diffuse uniform thickening of hyperostosis.

Treatment.—Care should be taken to prevent or remove epidermic or ceruminous accumulations, which are liable to form, when the canal of the ear is contracted. If a purulent discharge exists, whether its source be in the middle ear or in the external auditory canal, it should be carefully treated. The thickened cutaneous lining of the canal should be treated as directed at page 205. The cautious use of sponge or laminaria tents in order to produce a gradual mechanical pressure upon the osseous growths will often be followed by an increase in the width of the canal, after which treatment directed to the removal of the disease in the middle ear can be more effectively employed. The sponge tent is to be preferred on account of its being more gradual in its action. Iodine in solution has been recommended for internal use, and for painting the walls of the canal and the smooth surface behind the ear. It is doubtful if such treatment is attended by any effect.

Von Tröltsch suggests as a useful remedy in hyperostosis that a small abstraction of blood from the mastoid process, by means of a leech, should be employed every six weeks for a considerable length of time.

If retention of pus occurs in the middle ear, we must resort to perforation of the mastoid process (see p. 141).

4. Contraction of the Canal from Non-Inflammatory Causes.

A. Exostosis or Osseous Tumours.

These appear as hard rounded tumours of very various sizes, with circumscribed bases, projecting from the osseous walls of the canal of the ear (Fig. 56). They are more of the nature of tumours, while hyperostosis is rather an inflammatory hypertrophy. They are of two kinds, namely, those which have a pedunculated attachment, and those which are attached by a broad base. The latter or sessile are much more frequent than the former. These tumours are generally composed of solid bone, but occasionally they are found to be hollow.

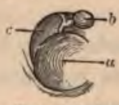

FIG. 56.—Two globular exostotic growths at the inner end of the external auditory canal—right ear. *a.* Larger, coming from antero-inferior wall. *b.* Smaller, coming from antero-superior wall. *c.* Tympanic membrane, behind upper part of manubrium.

Causes.—Exostosis is met with chiefly in men of middle age who eat and drink freely; and Toynbee believed the disease to be connected with the gouty or rheumatic diathesis. Frequent immersion of the head in water, as in diving, is said to give rise to these growths. The disease is frequently found associated with chronic non-suppurative catarrh of the middle ear. The same causes, which give rise to hyperostosis, probably also sometimes excite exostosis. Toynbee looked upon their formation as frequently part of a similar process in the walls of the middle ear. Researches in America have revealed a re markable frequency of exostosis of the canal of the ear in the skulls of the original transatlantic races. Hereditary disposition has probably an influence in the causation.

Subjective Symptoms.—These growths are usually very tender when touched with a probe. If the lumen of the canal is completely filled up there may be intense pain, due to the pressure of the expanding growth on the walls of the canal. If they have not developed to so great an extent as to close the canal, the patient has rarely a feeling of anything being wrong, and the presence of exostosis is first ascertained when deafness produced by epidermic or ceruminous accumulations brings the patient to the surgeon for advice. Or he may first ask the aid of the surgeon in consequence of the symptoms produced by the co-existing middle ear disease. When the exostosis has completely closed the canal, the deafness is, of course, very considerable or even complete.

Objective Symptoms.—We often find several of these growths in the same ear, and not unfrequently they are present in both ears of the same person. They appear as knob-like projections, of ivory hardness when touched with the probe, generally of a pale colour, but sometimes slightly red. If they are large, so as almost to close the passage of the ear, the skin over them may be thickened and spongy and of a reddish colour. The surface is quite smooth, or distinctly roughened. They may appear at any part of the canal, but the pedunculated variety is more frequently met with coming from the upper wall close to the attachment of the tympanic membrane. We sometimes see two or three globular growths, springing from opposite walls with only a fine slit between them.

Course.—The growth of these tumours usually extends over a long period of time. They sometimes, however, go on quickly to complete closure of the canal; or, on the other hand, after having reached a certain size, they may become quite stationary.

Diagnosis.—Their hardness, comparative paleness, and circumscribed form usually distinguish them from any other morbid growth in the canal of the ear.

Prognosis.—In very many cases they never develop to such an extent as to produce serious inconvenience. If the canal be completely closed, and if the growth cannot be removed, there is not only great impairment of the hearing, but there is always the possibility that, in the event of a purulent disease affecting the middle ear, a fatal issue may arise from retention of the purulent secretion.

Treatment.—The treatment described for hyperostosis is, in great part, applicable here. If the cutis of the canal be thickened, appropriate treatment should be used; or, if there be epidermic or ceruminous accumulations, these must be removed. No operative treatment is to be adopted, when the tumours are small and do not completely close the canal of the ear.

When the lumen of the canal is not quite obliterated, laminaria or sponge tents are sometimes used; but, in exostosis, these efforts by mechanical pressure are seldom efficient, and may prove dangerous. Von Tröltsch mentions a case in which a laminaria tent, which became so fixed that it was impossible to remove it for a considerable time, produced superficial necrosis, on the cure of which the lumen of the canal was found to be much wider. Even when the canal of the ear is completely closed by these osseous growths, operative measures are not in all cases to be undertaken. If there be total deafness in consequence of the hearing being also lost in the other ear, or if dangerous symptoms due to retention of secretion in the middle ear manifest themselves, operative treatment is demanded. There are two modes of operation employed.

1st, The use of hammer and chisel properly adapted for the purpose, and, 2nd, The use of the dental drill borer.* When there is retention of pus in the middle ear, an opening, by means of the hammer and chisel, may be required into the mastoid cells, especially into the antrum mastoideum (see p. 141). The operations for the removal of exostosis should only be undertaken by surgeons greatly experienced in dealing with diseases of the ear.

B. Congenital Contraction.

The canal of the ear may be altogether absent, or it may be so narrow, that the slenderest probe cannot be introduced. In these cases there is usually also congenital defect of the auricle, as well as of the middle ear and even of the labyrinth, so that an endeavour to form an artificial canal is rarely successful in giving better hearing. If, as in some cases, there is simply great contraction of the cartilaginous part of the canal from congenital causes, persevering efforts to dilate this portion by laminaria or sponge tents may have good results.

In some persons we find that the anterior and lower wall of the middle part of the osseous canal projects so much towards the lumen of the canal, that only the upper part of the membrane is visible. The only inconvenience of this abnormality is the hindrance which it presents to examination of the membrane or to operations upon it.

C. Collapse of the Cartilaginous Part of the Canal.

This is found chiefly in persons of advanced age, and is caused by the approximation of the posterior to the anterior wall at the entrance to the ear. This approximation is probably due to an over-flaccid condition of the fibrous tissue and skin, which form the upper and back walls of the cartilaginous canal. The entrance to the ear may in this way be reduced to a mere slit. This rarely interferes with the acuteness of hearing; but, if it does so, the patient should employ a small silver tube of the same shape, but rather smaller than an ear speculum. This is to be kept in the ear only when it is important that the patient should hear. As has been already mentioned, accumulation of cerumen is likely to take place in this condition, owing to the hindrance to its normal removal from the ear.

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* The operation is very minutely described in Field's "Diseases of the Ear," 1882. Chapter v.

5. Syphilitic Diseases of the External Auditory Canal.

In the form of condylomata or ulcerations, syphilis is occasionally found in the external canal of the ear, especially near the outer orifice. These belong to the secondary symptoms of syphilis, and are usually associated with a syphilitic throat affection. Condylomata at the outer orifice of the ear are, however, sometimes met with during the primary stage of syphilis. The condylomata usually occupy the outer orifice of the ear, appearing as a greyish-red mass of granulation tissue yielding a fœtid discharge. A small opening is found in the centre of the mass leading into the canal of the ear. Diffuse otitis externa is generally excited, causing considerable swelling of the walls of the canal, and, in some cases, pain of an intense, radiating character. Syphilitic ulcerations of the external auditory canal are usually circular in shape with thickened edges and having a dirty white appearance. Both the condylomata and ulcerations are apt to leave patches of pigment or cicatrices, and the cicatricial tissue may seriously contract the lumen of the canal.

Treatment.—We must of course employ general antisyphilitic treatment (f. 98 to 101). Great attention should be given to local cleanliness by frequently bathing or syringing the ear with warm water containing a disinfectant substance (f. 50 to 53). If long and ragged, the condylomata should be cut off with scissors, and solid nitrate of silver afterwards applied several times. Dusting the masses occasionally with calomel powder also helps to bring about their disappearance. The ulcerations should be treated with a strong solution of nitrate of silver (40 grs. to an ounce) applied every second or third day for a number of times. An ointment, composed of 10 grains of iodoform to an ounce of vaseline, forms a useful application in addition to cauterization. Filling the ear three times a day with a warm solution of bichloride of mercury (4 grains to the ounce of water) is recommended by some writers.

6. Fungi in the External Auditory Canal—Otomycosis.

Schwartze and Wreden were the first to direct attention to symptoms, similar to otitis externa, produced by the growth and accumulation of certain fungi, generally belonging to the species of aspergillus. These fungi were usually most developed in the inner third of the canal and on the outer surface of the tympanic membrane.

Causes.—These fungous masses are chiefly met with in an external auditory canal where there has previously been disease, which has led to accumulations of epidermis, these seeming to form a nidus for the germination and growth of the parasite. A profuse purulent secretion is unfavourable to the life of the fungi. They are most frequently found in the male sex. Oil poured into the canal of the ear, and allowed to lie and become rancid, is said by Bezold to favour their development, and damp dwellings are said to have the same effect. Judging from German writers and from its rarity in this country, it is not so common a disease in Britain, as in continental countries.

Subjective Symptoms.—These are usually pain, impairment of hearing, and some form of tinnitus aurium. The pain may be slight, but it is more often of a very intense character.

Objective Symptoms.—These depend on the kind and state of development of the parasite. The accumulations in the ear are usually of a blackish colour from the spores of the aspergillus nigricans (Fig. 57). In this variety the heads of the hyphens appear as small black points. When, on the other hand, the fungus belongs to the variety aspergillus flavescens, the collections are whitish or greyish, the heads of the hyphens forming yellowish points. Microscopically these fungi are found lying between and covering

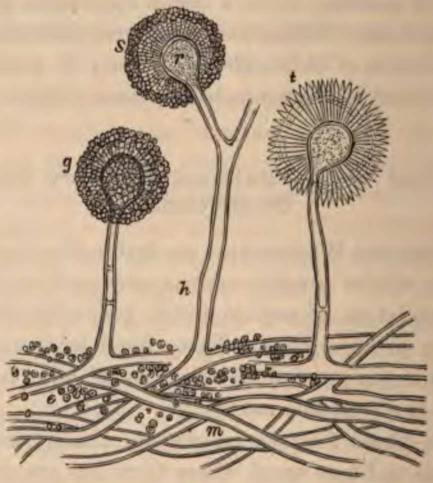

FIG. 57.—Aspergillus Nigricans. *g*, Gonidia; *h*, Hyphæ; *m*, Mycelium; *r*, Receptaculum; *s*, Spores; *t*, Sterigmen (Urbantschitsch).

the epidermic scales. They adhere very tenaciously to the tympanic membrane and to the inner parts of the walls of the canal. When they are removed the cutis beneath is found to be reddened, thickened, and sometimes with a tendency to bleed.

Consequences.—These masses are very likely to maintain a condition of chronic otitis externa, exciting occasionally acute exacerbations of the inflammation. Their presence may also lead to serious injury to the walls of the canal and the tympanic membrane. If imperfectly treated, and the fungus not thoroughly eradicated, there is a great tendency to relapses.

Diagnosis.—The disease is apt to be confounded with accumulations of cerumen. When collections in the canal of the ear are attended by great pain, we may suspect this disease. Microscopic examination is, however, the only means of arriving at a certain diagnosis.

Prognosis.—This is very favourable, when we are aware of the precise nature of the disease.

Treatment.—We should first use the syringe and warm water medicated with carbolic or salicylic acid or permanganate of potash (f. 50 to 52), till we succeed in completely removing the masses contained in the ear. The syringing often requires to be repeated several times with occasionally the aid of forceps before this is effected. After this has been done, it is sometimes essential, in order to prevent the regrowth of the fungi, to introduce some more decided parasiticide. Various forms of these may be employed. Rectified spirit of wine or a solution of bichloride of mercury (6 grs. to the ounce) answers well. Either of these, after having been warmed, are poured into the ear, and allowed to remain there for ten minutes at a time—this process being repeated several times a day for three or four days.

If cotton be used for stopping the ear it should be carbolized or impregnated with salicylic acid.

7. Foreign Bodies in the External Auditory Canal.

For convenience of description, we shall divide the foreign bodies which may be found in the ear into two classes. 1st, Mineral and vegetable substances; and, 2nd, Insects, larvæ, &c.

A. Mineral and Vegetable Substances.—These are very diverse in nature, size, and shape, including such bodies as beads, peas, small buttons, small stones, stones of fruit, pieces of paper, bits of bread, small pieces of slate pencil, or of wood, &c. They may get into the ear by accident, or they may be pressed into the external meatus by children in play, or by persons for superstitious reasons.

Symptoms.—In whatever way foreign bodies get into the ear, the kind of phenomena called forth by their presence depends upon their size, their shape, their chemical and mechanical nature, and upon the force used in introducing them. A small, smooth, round body, for example, such as a bead, may lie in the canal of the ear for almost any length of time without exciting any morbid sensation. Many cases are recorded in the literature of the subject of small bodies remaining for many years without provoking any irritation. On the other hand, if the object be larger, and if it happens to have been pressed deeply, and with great force, into the ear, either at its admission or by subsequent efforts to extract it, serious symptoms and consequences may ensue from the pressure, and injury may be inflicted upon the walls of the canal or upon the tympanic membrane.

When the foreign body simply occupies the lumen of the canal, exerting but slight pressure on its walls, the subjective symptoms produced by it will probably be limited to some degree of deafness, and more or less tinnitus aurium. If the object be larger, and if it be forcibly pressed deeply into the canal of the ear, or if it be a smaller object, but of a vegetable nature, such as a pea, which after admission has become larger by the absorption of fluid, pain of greater or less severity will be excited. If the pressure upon the walls of the canal be still greater, and, particularly, if the foreign body also presses upon the tympanic membrane, the pain may be of a most intense character, and will soon be followed by severe otitis externa, or even by otitis media. Many unfortunate cases have been recorded of more serious symptoms still, leading even to fatal consequences. There can be little doubt that these have been frequently due to the injuries inflicted by the reckless and improper use of instruments, and not to the undisturbed presence of the foreign body.

Peculiar reflex phenomena in other organs have been occasionally found in connection with foreign bodies in the ear. These phenomena are to be explained by the mechanical irritation exercised upon the numerous nerve twigs, from the trigeminus and the vagus, which are distributed in the cutaneous lining of the external auditory canal and tympanic membrane. Thus cases are recorded of persistent cough, epileptiform attacks, giddiness, vomiting, constant sneezing, &c., due to the presence of foreign bodies in the ear, the removal of which was attended by the disappearance of these symptoms.

Diagnosis.—When a person comes before the surgeon, stating that a foreign body has got into his ear, the first point to determine is, whether the ear *really* contains such a body, for cases have come under the observation of most aural surgeons, in which the ear has been injured by the efforts of medical men to remove a foreign body by means of instruments, when a careful examination would have shown that no such body existed in the ear. It is evident that a small round object which has gone into the ear, without being actually pressed therein, may pass out again. Hence before the patient comes to the surgeon, the object may have dropped out of the ear during sleep, or during some movement of the head, quite unnoticed by the person. Such a possibility makes it necessary that *the statement of the patient should always be tested by inspection with the reflecting mirror and ear-speculum.* We must never trust to the sense of touch given by a probe, introduced into the canal of the ear, without the aid of the eye and of thorough illumination of the interior of the ear. The sensation given by the contact of the point of a probe with the osseous walls of the canal may easily deceive the examiner into the opinion that he is touching a hard foreign body in the ear.

In most cases, we are able at once to view every part of the interior of the ear, where a foreign body can lie, with the aid of the reflecting mirror and speculum. If, however, there has been a pre-existing perforation in the tympanic membrane, the foreign body may have passed into the tympanic cavity, and may thus escape beyond the reach of vision. Or the walls of the canal may be so much swollen by inflammatory reaction, that the object is rendered invisible. In either of these cases the cautious use of the probe, while the interior of the ear is illuminated, will usually remove any doubt.

Or the object, if a small one, may be hidden from view in the *sinus* of the external auditory canal. This in some persons is so deep that we are unable, by any methods of examination, to see the bottom of it. If the patient reports that a small foreign body is in the ear, and if, on examination, no such body can be seen, we should, if unable to get a complete view of this sinus, syringe the ear two or three times with warm water. If there is really a foreign body in the ear, we shall find either that it is washed out of the ear by the syringing, or that it has been so displaced by the injected water, that it is brought into view, when we again inspect the interior of the ear.

Or, lastly, a small sharp object, when embedded in the skin of the external auditory canal, may be readily overlooked if the walls of the canal be not thoroughly scrutinized.

Treatment.—Having assured ourselves that there *is* a foreign body in the ear, we have next to decide upon the best and safest methods of removing it.

Before describing these methods in detail, it may be well to mention a few general points, which should be kept in view by the surgeon, when he has to deal with a foreign body in the ear.

1*st*, Most of the foreign bodies which find their way into the ear (such as small beads, small round stones, tiny bits of bread or of paper, and such like), are much smaller than the lumen of the canal, and do little harm by their presence. In such cases the patient or the friends, who are often very much excited, should have their minds calmed by the assurance that a little delay in the removal of the foreign body will do no harm.

2*nd*, The immediate resort to instrumental or operative interference, when a foreign body is in the ear, irrespective of its size, position, or nature, must be earnestly deprecated. The presence of a foreign body is, in the great majority of cases, much less injurious than attempts to remove it by instruments in the hands of those little accustomed to aural work.

3*rd*, If the canal of the ear is found to be intensely painful, and its cutaneous lining in a state of acute inflammation from the irritation of the foreign body, or, what is more likely, from the efforts made, by means of instruments, to remove it, we should employ remedies to remove the pain and the inflammation, before we attempt to extract the foreign body.

4th, If instruments are found to be necessary, the surgeon should be extremely gentle and cautious in their use. The interior of the ear must be properly and thoroughly illuminated by means of a reflecting mirror fixed to the forehead, so that in his manipulation every movement of his hand may be guided by the eye. An anæsthetic may be administered, if the patient be a restless child or a very unsteady adult.

In deciding upon the best and safest method of removing a foreign body from the ear, we must be guided by the size, shape, and nature of the substance and the part of the canal, in which it is found.

With small objects which neither fill the lumen of the canal, nor exert any pressure on its walls, and these, as we have already seen, are the most common, the treatment is simple, safe, and effective. This consists in the proper use of the syringe and warm water. A few well directed streams of warm water will soon be followed by the expulsion of the body.

When, however, we have to deal with larger bodies, which may have been pressed forcibly into the ear, and which are firmly embraced by the walls of the canal, there is greater difficulty in extracting them.

The degree of difficulty will depend—first, upon the situation of the foreign body with respect to the *isthmus* of the external auditory canal. This is that part of the canal where there is usually a considerable projection of the antero-inferior wall, causing a well marked narrowing of the lumen of the canal. Between this projection and the tympanic membrane there is a gradual sinking of the floor, forming the sinus already referred to. If the foreign body is outside of the isthmus, its removal is generally easy either by means of the syringe used under the conditions which are about to be stated, or by some one of the instruments which we shall afterwards describe. *The greatest care must be taken in order to prevent the foreign body being forced from this favourable position to a part of the canal beyond the isthmus.* If it has been forced beyond the isthmus into the sinus of the canal, its removal is very much more difficult, and may require the most skilful manipulation. The difficulty is rendered still more formidable if the foreign body has become tightly fixed in this position either by the swelling of the object, if of a vegetable nature, or by inflammatory swelling of the cutaneous lining of the canal.

Secondly, the degree of difficulty will also depend to a considerable extent upon the presence or absence of a gap between some part of the foreign body and the walls of the external auditory canal. The lumen of the canal being oval in shape, and foreign bodies being often round, there is frequently such a gap, the exact situation of which should be carefully ascertained by inspection, in order to direct the stream of water through it when syringing the ear. If this precaution be neglected, the stream of water, instead of expelling the body, may drive it further in.

The syringe used should have a slender nozzle which, during syringing, must be directed towards the gap between the wall of the canal and the foreign body. The addition of soap to the warm water makes it more easy to move the body from the position it has taken up. While syringing, the auricle is to be pulled upwards and backwards with the left hand so as to remove the curve of the canal as far as that is possible. The head of the patient should also be inclined downwards towards the side to be syringed, in order that, by making the floor of the external auditory canal an inclined plane, the movement of the object outwards may be assisted. When the water is in this way injected behind the foreign body, the latter will be gradually urged by the pressure of the water towards the external orifice of the ear. After it has reached the outer orifice, if it does not drop out, it may be easily and safely removed.

If the foreign body is a vegetable substance, such as a bean or pea, and the treatment by syringing be employed, we must be prepared to remove it at one sitting. If we allow some time to elapse, after injecting warm water, the pea or bean will swell from absorption of fluid, and it will thus become more firmly impacted, and will be much more difficult to remove.

If, after a fair trial with the syringe, we fail to move the body outwards, some form of instrument may be necessary, either to extract the foreign body, or so to displace it, that subsequent syringing may be more successful in bringing it away.

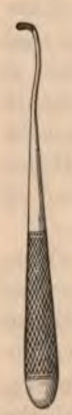

FIG. 58.

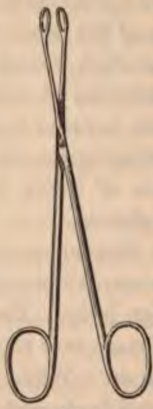

FIG. 59.

FIG. 58.—Lister's instrument for removing foreign bodies from the ear.

FIG. 59.—Forceps of Dr. Guye for removing foreign bodies from the ear.

Ordinary forceps must be discarded as being very likely to force the foreign body further into the canal of the ear.

A very thin slightly curved instrument, used as a lever, is useful, and, with the precautions already mentioned, is quite safe. An excellent form of such an instrument (Fig. 58) was introduced by Professor Lister, who, many years ago, took great pains in devising it. In seeking for the best form of instrument, Professor Lister pressed pebbles and other objects into the ear in the dead subject, and experimentally tested upon them the efficiency of different forms of instrument. He found the instrument figured in the annexed woodcut the most suitable.

If there is a gap between the foreign body and the wall of the canal, such an instrument should be insinuated through this space and used as a lever to urge the body outwards. If there is no such gap, the foreign body being firmly impacted in the canal, the careful use of such a fine lever instrument will frequently enable us to expel the foreign body, or by displacing it, or by making a small gap between it and the walls of the canal, the use of the syringe and the warm water may be more effective.

The forceps suggested by Dr. Guye, of Amsterdam, and shown in the woodcut (Fig. 59), are of great service. The instrument consists of two branches, which are made to fit into and move on one another by means of a pivot. The ends of the branches resemble the blades of midwifery forceps in miniature. These fine small blades are introduced separately on each side of the foreign body, and, the two branches of the forceps being connected by the pivot joint, gentle traction is made. One of the blades, used as a lever, is sometimes sufficient to give us the required aid, or in making a gap when none exists.

A wire loop, as in Wilde's snare (see p. 138), is a safe method of attempting to remove a foreign body. If we are able in this way to encircle the object we may succeed in bringing it away, or we may be able so to change its position that its removal by the syringe, or by the lever instrument, is rendered easy or possible. The wire loop is of especial value when the foreign body has passed through a perforation in the tympanic membrane to the tympanic cavity. We may also assist the expulsion of an object from the tympanum by the air douche, or by fluid injections, through the Eustachian tube, or by suction, by means of a Siegle's speculum fitted air-tight into the external auditory canal.

If we have to deal with a pea or bean, which has undergone swelling by absorption of fluid, and has consequently become tightly impacted in the deep part of the canal of the ear, it may be necessary to break it down with a fine bent hook and remove it piecemeal or by the syringe. Voltolini recommends the galvanic cautery in certain cases, such as that of a tightly impacted bean, which may in this way be diminished in bulk by the partial destruction of its substance.

A suggestion of Löwenberg, of Paris, also deserves mention. He proposes that, after the object has been thoroughly dried, a fine brush, which has been dipped into a solution of glue, should be applied to the foreign body, and then, after waiting for thorough drying and adhesion, the brush with, it is hoped, the foreign body glued to it is to be withdrawn from the ear.

If the object is long and pointed, and if it lies across the canal, with the points piercing its walls, as may happen with a needle or a piece of necrosed bone, it may require to be broken with forceps, and the pieces afterwards extracted separately.

It only remains for us to consider certain cutting operations, which are recommended in cases where we are unable to achieve our object by the methods referred to, and where the symptoms produced by the foreign body are of such an urgent and serious character, as to make its immediate removal from the ear imperative. In most of such cases the body has found its way into the deep parts of the canal or into the tympanum and, by cutting from behind, above, or below the cartilaginous part of the canal, and separating the cartilaginous from the osseous part, we may gain more complete access.

Cases are related in which the mastoid process has been perforated from without, in order to extract or expel a foreign body contained in the tympanic cavity. The necessity for these operations, however, arises very seldom.

B. Insects, Larvæ, &c.—Various insects, as fleas, bugs, flies, &c., sometimes find their way into the ear. Country folk, sportsmen, and field workers are more likely than towns-people to be tormented by insects crawling into the ear.

The subjective symptoms set up depend upon the kind of insect which has got admission to the ear. There may be only the sensation of a moving body in the ear. But on the other hand, it is said that the presence of a flea may set up loud and most disagreeable noises, and even severe pain, by its leaping upon the tympanic membrane and the walls of the external auditory canal. A bug may excite very great pain by fastening upon and sucking some part of the canal or the tympanic membrane. The ear-wig (*forficula auricularia*) is an object of great dread to many persons, owing to the belief that if it gets into the ear it will make its way to the brain, and produce some dreadful result. While it is true that this creature sometimes runs into the canal of the ear, any such hole having an attraction for it, there is no evidence that it has, on any occasion, produced any mischievous effect.

The fly (*muscida sarcophaga*), attracted by the odour of the pus, in neglected chronic purulent disease of the ear, sometimes deposits its eggs in the entrance to the ear, causing the development of larvæ or maggots. These may be found in great numbers, chiefly at the inner end of the canal, and in the tympanum, appearing as white worm-like creatures, moving rapidly about. These larvæ are furnished with hook-like apparatus, which fasten upon and penetrate the tissue, exciting in this way the most intense pain. Sometimes, however, no pain attends the presence of these larvæ in the ear.

Treatment.—It is easy to kill or expel insects, which have found their way into the ear, by pouring water or oil into the ear, and allowing it to remain for ten minutes. If these are not at hand, the smoke of tobacco from a cigar or pipe, blown into the canal of the ear, will quickly compel the insect to find its way into the open air. The expulsion of larvæ is to be effected by a more difficult process. Syringing with warm water will neither kill nor expel them. We must first apply some substance to the interior of the ear, which will cause the death of the larvæ. Roosa recommends that a solution of chlorinated soda be poured into the ear. Rectified spirit, or the vapour of chloroform, is usually very effective. After they have been killed, they may require to be removed individually with forceps, as even after death they so adhere to the walls of the canal, that simple syringing will not suffice to bring them away.

It is possible, in applying leeches to the neighbourhood of the ear, that one of them may escape into the ear. If such an accident should occur, a solution of common salt must at once be poured into the canal, after which the leech may be syringed out, or removed with forceps.

CHAPTER III.

THE TYMPANIC MEMBRANE.

THE tympanic membrane is lined on the outer surface by skin and on the inner surface by mucous membrane. Only its outer aspect therefore belongs to the parts of the ear covered by skin; but we have thought it right to include the description of this membrane and its diseases here, not only because in its mode of development it belongs more to the external auditory canal than to the tympanum, but also because its nervous and vascular supplies are mainly derived from the cutaneous lining of the external auditory canal, and because disease or accident primarily affecting this structure is usually the result of causes acting from without.

ANATOMICAL AND PHYSIOLOGICAL DESCRIPTION.

The tympanic membrane, *membrana tympani*, or drum head (not the "drum") (Fig. 60), is a thin but strong in elastic membrane, which is stretched across the inner end of the external auditory canal. It is not tightly stretched, being capable of a considerable extent of movement, when the air in the external auditory canal is alternately condensed and rarefied. It is fastened to a groove in the bone, the *sulcus tympanicus*, by means of strong connective tissue. This sulcus is, however, defective above, where the bone is hollowed out into a cavity, the *Rivinian segment.* That part of the membrane filling up the Rivinian segment is thinner and looser than the rest of the membrane, and is termed the *membrana flaccida*, or Schrapnell's membrane. It is not fixed to the bone, but simply connected to the skin of the canal of the ear. The loose attachment, as well as the absence of the fibrous layer, renders this part of the membrane more flaccid than the rest. The shape of the tympanic membrane varies in different persons, but is usually somewhat oval. Its longest diameter is from above downwards, and measures from 9 to 10 millimètres or about $\frac{3}{8}$ths of an inch, while its horizontal diameter is usually one millimètre less.

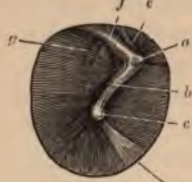

FIG. 60.—Outer aspect of right tympanic membrane, double the natural size—*a*, short process; *b*, middle of manubrium; *c*, umbo; *d*, cone of light; *e*, membrana flaccida; *f*, posterior fold; *g*, long process of incus shining through the membrane.

It is not placed upright, but is so sloped as to form an angle of 140 degrees with the upper and back wall of the canal, and one of 45 degrees with the lower and front wall. On account of this oblique position the upper and back part of the membrane is nearer to the external orifice of the ear than the lower and front parts, a fact which should be borne in mind when operating upon the membrane or the external canal.

It is also curved in such a way that its outer surface presents a general concavity. This is caused mainly by the inclination of the manubrium or handle of the malleus, and the deepest part is at the lower end or umbo of that bone. Although there is this general concavity outwards, the membrane at several parts presents small bulgings towards the outside. These are in the situation of the cone of light, the short process of the malleus, and the anterior and posterior folds to be described presently.

The general colour of the membrane as seen from without during life is usually a pearl grey. In childhood it has a darker grey colour, while in old age it is whiter and more opaque. Immediately behind the umbo the membrane is whiter on account of its nearness to the whitish inner wall of the tympanum. The upper and back part has also generally a whiter appearance, which is due to the chorda tympani nerve and the posterior pocket of the membrane shining through.

The outer surface has, during life, a bright polished appearance, due to the reflection of light from the finely deposited layers of epidermis. At the antero-inferior part the lustre is especially bright, and from its triangular form this is named the triangular light or the *cone of light*, the apex of this bright reflex being at the umbo and the base at the antero-inferior periphery of the membrane. The cone of light varies, even in healthy membranes, in length, breadth, and distinctness. In certain morbid conditions, especially after inflammation chiefly affecting the cutaneous or outer layer, the general polish as well as this cone of light may be dimmed or completely absent. For the description of the appearance of the membrane when seen through the external auditory canal see p. 10.

In early childhood the membrane possesses several peculiarities worthy of notice. 1st, It is thicker and in proportion to the size of the body much larger than in the adult; indeed, shortly after birth it has attained almost its complete size. 2nd, It is rounder in shape and darker in colour than in the adult. 3rd, Its position is more horizontal. At the end of fœtal life it really forms part of the *base* of the skull, and is almost on a line with the roof of the external auditory canal. With the development of the lateral walls of the skull, the membrane gradually takes the position which it has in the adult.

The tympanic membrane, with the exception of that part called the membrana flaccida, consists of three layers:—1. A cutaneous or outer; 2. a fibrous or middle; 3. a mucous or inner. In the membrana flaccida the fibrous layer is absent. The cutaneous layer can be easily separated from the middle layer, which, however, is intimately and inseparably united with the mucous layer.

The *external* or cutaneous layer is a very fine transparent prolongation of the lining of the external auditory canal. It is destitute of hair or the glandular elements of skin, but is formed not only of epidermis, but also of connective tissue elements. This layer is very rich in blood-vessels and nerves. At the upper part, where this layer is thickest, the chief vessels and nerves pass down from the cutaneous lining of the roof of the canal, along the posterior edge of the manubrium to the umbo, from which the vessels radiate in small branches to the periphery, where they anastomose with smaller vessels from the other walls of the canal. These vessels, especially those passing down the membrane from the upper wall of the canal, become injected under various conditions apart from actual inflammation. After syringing the ear, after prolonged examination with the speculum, during the performance of the Valsalva experiment, or after suction by Siegle's speculum, they are much injected. After inflammation of the membrane the cutaneous layer often becomes thickened and opaque, so that the manubrium may be completely obscured.

The *middle* layer, frequently termed the membrana propria, is the strongest layer of the membrane. It is composed of two sets of fibres, the outer or radiating and the inner or circular. The radiating fibres, forming the lower part of the membrane, are attached to the umbo, while the others are fixed to the anterior edge of the manubrium. The circular fibres are thickest in that zone of the membrane, which is intermediate between the centre and the circumference. The manubrium is fixed between the radiating and the circular fibres. This layer is said to be destitute of vessels and nerves; and the peculiar arrangement of the fibres contributes to the strength of the membrane.

The *inner* or mucous layer is a continuation of the mucous lining of the tympanum. It is extremely thin and delicate, but in chronic catarrhs of the middle ear it often becomes very much thickened. Its vessels are supplied by the tympanic vessels, and they anastomose with those of the cutaneous layer at the periphery of the membrane. It has much fewer nerves than the cutaneous layer. The so-called pouches of the membrane found on its inner aspect will be afterwards referred to under the description of the anatomy of the tympanic cavity.

The tympanic membrane serves several purposes. It protects the middle ear from the effects of injurious atmospheric and other external influences. It supports the outer end of the bridge of bones, which spans the cavity of the tympanum. It is endowed with great capacity for vibrating in response to waves of sound transmitted to it by the column of air in the external auditory canal, and communicates these vibrations to the ossicles. Helmholtz has shown experimentally that a curved membrane has more capacity for resonance than a flat membrane; but, on the other hand, Fick has demonstrated that the obliquity of a membrane weakens the effects of sonorous waves falling upon it. Vibrations corresponding to tones of all varieties of pitch and intensity are received at the one instant by this membrane and transmitted along the chain of bones.

The non-elastic character of the membrane is supposed to prevent the tendency to after vibrations; and it has been asserted that the radiating fibres are comparable to a system of stretched strings fixed at the one end and at the other attached to a movable cross-bar.

DISEASES OF THE TYMPANIC MEMBRANE.

As we might expect from its situation as a partition separating the external auditory canal without from the cavity of the tympanum within (Fig 61), this membrane generally shares in the diseases of these neighbouring parts. In these cases the affection of the membrane is *secondary* to that of the external auditory canal or tympanic cavity; and these secondary changes, such as perforations, calcareous deposits, &c., will be considered, when we come to the diseases of the middle ear, of which they are usually the consequences. Primary disease of the membrane is, however, also met with, although not nearly so frequently as morbid secondary changes. As from the position of the

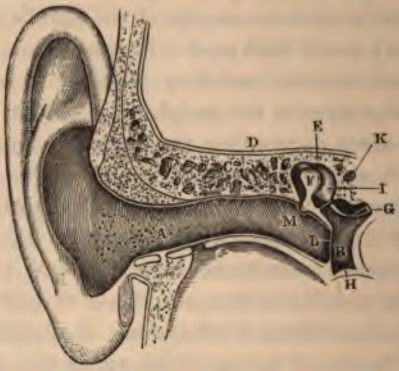

FIG. 61.—Section of tympanic membrane—L, showing its position as a partition between the external auditory canal and the tympanic cavity.

membrane primary disease very often extends to the neighbouring parts, it is generally difficult, and sometimes impossible, to say whether the disease is a primary one of the membrane, or whether it is secondary to a process, which has had its origin in the tympanum or the external auditory canal. We shall describe—1st, Acute and chronic inflammation of the tympanic membrane (acute and chronic myringitis); and 2nd, Injuries of the tympanic membrane.

1. Acute Inflammation of the Tympanic Membrane—Acute Myringitis.

The inflammatory process may affect the whole of the three layers of the membrane, or it may be limited to one layer. Usually it affects only one ear.

Causes.—Many of the causes, which have been mentioned as likely to exite acute otitis externa, may also produce acute myringitis. The action of cold air, or of cold water, is a common exciting cause. Inflammation produced by fungi may be limited to the tympanic membrane (myringomycosis). Foreign bodies in the ear, injuries of the membrane, the pressure of cerumen, irritating substances applied to the interior of the ear, violent syringing, especially when there is nothing to remove,—any one of these may excite an acute myringitis.

Subjective Symptoms.—The first symptom is usually local pain, often of a very severe character, and radiating over the corresponding side of the head. The pain frequently comes on suddenly at night, preventing sleep, and it may be attended, in childhood, by some degree of feverishness. If an abscess forms in the interstices of the membrane, the pain is especially intense and worse at night. In milder cases, as when the inflammation is superficial, the pain may be slight and of short duration, or there may be only a sensation of fulness and pressure. Subjective noises in the ear of a pulsating or ringing character are also generally present. The pain and the noises are usually intermittent, and cease when the ear becomes moist or with the escape of some blood. There is usually some degree of deafness, due not only to the swollen state of the membrane, but also to some concomitant hyperæmia of the tympanum, and even of the labyrinth.

Objective Symptoms.—During the first stage we find the tympanic membrane, either partially or wholly, in a state of hyperæmia. The injection of the vessels is usually especially well marked where the cutaneous lining of the membrane is thickest, that is, over the upper part of the membrane, and along the manubrium. The manubrium may be quite concealed by a thick bundle of injected vessels. From the lower end of the manubrium the injected vessels are often seen to radiate to the circumference of the membrane. The membrane also appears flatter, and its polish is gone. Later on, the membrane may have a uniformly red colour, the individual vessels being no longer seen. When the inflammation is very intense, and in the deeper layers, the colour may be a bluish-red. The short process is sometimes seen like a white pustule in the centre of the red mass.

In the second stage we have interlamellar transudation of serous fluid, the epidermic lining being at parts raised from the cutis by serous fluid, or by pus or sometimes by blood. In other cases the epidermis is thrown off, and appears as sodden flakes in the deep part of the external canal of the ear, while the denuded parts of the membrane are red, swollen, spongy-looking, and partly covered with secretion. The small interlamellar abscess, or vesicle, or ecchymosis, due to the elevation of the epidermis by pus, serum, or blood, is usually found at the upper and back part of the membrane. There may be two or three of them (Fig. 62). We may find at a part of the membrane, where a perforation is threatening, a superficial ulcer, having for its base the lamina propria or the mucous layer. At this stage also the cutaneous lining of the inner end of the canal is in a state of hyperæmia and swelling, effacing the usually distinct boundary between the walls of the canal and the membrane. The glands under the lobule of the auricle are also usually tender and somewhat swollen.

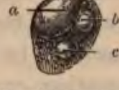

FIG. 62.—Appearance of tympanic membrane in second stage of acute myringitis—*a*, large interlamellar abscess at upper and back part of membrane; *b* and *c*, smaller interlamellar abscesses.

Course.—The morbid process begins to abate, in favourable cases, in from three to six days. The vesicles or abscesses having discharged their contents, the hyperæmia and swelling pass off and ultimately the epidermic lining again forms. In scrofulous or tubercular persons or when under improper treatment, the morbid process may be much prolonged, or it may lead to certain undesirable consequences.

Consequences.—Pretty frequently ulceration and perforation of the membrane result from acute myringitis. In this way the disease may lead to a chronic suppurative inflammation of the middle ear. A chronic otitis externa may also result from a badly treated myringitis. When the deep layers of membrane are the seat of inflammation, there is likely to be also swelling and exudation in the middle ear. Occasionally there is left behind a permanent thickening of the membrane, especially of its cutaneous layer, and sometimes in consequence of this thickening the manubrium appears much less distinct or is altogether invisible. From the same cause the membrane appears flatter, more opaque and less lustrous. Myringitis, attended by the formation of an interlamellar abscess, is probably the most important cause of calcareous deposition in the membrane, from the partial absorption, inspissation and calcification of the pus.

Diagnosis.—In the later stages of the disease, when the inflammation may have extended to the cavity of the tympanum or to the external auditory canal, it is very dificult to say whether we have to do with a primary or a secondary myringitis. It is most apt to be confounded with acute otitis media. In myringitis, however, the injection of the membrane is seen to be more superficial, the deafness is less marked, and inflation of the middle ear tends to aggravate myringitis, while it benefits otitis media. Interlamellar abscess of the membrane is to be distinguished from a collection of secretion in the tympanum by the thin covering, the sharp border, and the occasionally multiple nature of the former. When the swelling is gently pressed with a probe a slight depression is left for a short time, if we have to do with an interlamellar abscess. When the latter is punctured only a small quantity of fluid escapes, and no perforation remains behind.

Prognosis.—If treated rightly, acute myringitis usually ends in complete recovery. Even when the membrane is perforated, this is usually easily healed, if there is no disease of the middle ear. The hyperæmia of the cutaneous lining over the manubrium is usually the last symptom to disappear.

Treatment.—In order to protect the membrane from the cold air and the effects of loud sounds, a plug of cotton wool should be kept in the external meatus. The treatment of the early stage should be pretty much the same as that of acute otitis externa (see p. 198). In acute myringitis, however, the leeches should be applied both to the tragus and the lower part of the mastoid process. The patient should avoid, if possible, violent expiratory movements, such as coughing or sneezing, in order to avert tearing of the soft and weakened membrane.

Some writers recommend incision of the inflamed tissues, when there is great redness and swelling. Schwartze recommends it "in certain cases of acute inflammation of the membrane, when the postero-superior quadrant of the membrane becomes in a short time intensely swollen and of a dark bluish red colour, with most acute pain, which is not relieved by the other measures." By the relief of the tension of the tissue and perhaps also by direct depletion of the vessels of the membrane, the paracentesis in such cases quietens the pain, and shortens considerably the course of the disease. The opening in the membrane soon closes again, and never comes to ulceration.

In the great majority of cases the treatment recommended for acute diffuse inflammation of the external auditory canal will be quite sufficient. Abscesses or vesicles usually rupture spontaneously in a short time. If, however, there is very great pain, which is not removed by ordinary treatment, and if a yellowish green circumscribed swelling is found on the membrane, this swelling should be punctured. When the pain and other acute inflammatory symptoms have disappeared, while considerable deafness is left behind, inflation of the middle ear, by Politzer's method, should be practised a few times.

2. Chronic Inflammation of the Tympanic Membrane—Chronic Myringitis.

Causes.—This may be developed out of an acute attack, or the disease may be mild from the beginning. In chronic disease of the external auditory canal, and more especially of the middle ear, the tympanic membrane is often in a corresponding state of inflammation. We are rarely able to say positively whether it has originated in a primary myringitis or in disease of the adjoining parts.

Subjective Symptoms.—The subjective symptoms are slight, consisting of some itchiness, a sense of moisture in the ear, and more or less dulness of hearing.

Objective Symptoms.—Some purulent secretion, generally having a foul smell, is usually seen in the external auditory canal and upon the membrane. The latter may be at parts red and swollen and at parts covered with sodden epidermis or crusts. The membrane becomes thickened and rigid in consequence of new connective tissue formation in the different layers. On the free surface we may have granulations or polypoid growths. Some parts of the membrane may be quite normal, while other parts may have undergone important pathological changes. There may be partial indrawing of the membrane and even adhesion with parts of the tympanic walls.

Course.—Its course is very slow, and extends, it may be, over many years, gradually leading to pathological changes in the membrane or in the adjoining parts.

Consequences.—Permanent thickening and rigidity; calcareous deposition; atrophy; perforation; or chronic disease of the middle ear or of the external auditory canal may result from this disease.

Diagnosis.—If perforation of the membrane and disease of the middle ear be present, it is impossible to decide whether the pathological condition of the membrane is the primary or the secondary disease. If the hearing is not very much impaired, and if the secretion is not large in quantity, the probability is that the disease is mainly confined to the membrane.

Prognosis.—This is much less favourable than in the acute form. We never can have complete restoration of the tissues to their normal condition. Long-continued treatment is usually successful in putting an end to the secreting process and in producing some improvement of the hearing, but the marked thickening, due to new interstitial formation of tissue, can only be very partially improved.

Treatment.—The treatment of chronic myringitis is included in that of chronic purulent disease of the middle ear. If the disease be mild, the treatment by means of cleansing and astringent lotions, as described at p. 200, should be employed. If, after two weeks' trial, this is not effectual, a strong solution of nitrate of silver, used as described at p. 368, should be employed three times a week for two weeks. Granulations should be touched, every third day, with solid nitrate of silver, or a strong solution of perchloride of iron. Polypi are to be removed, and treated as described at p. 383. Various applications are recommended for a thickened membrane. Wilde recommends the internal use of mercury, and the ointment of potassium iodide in the neighbourhood of the ear. If the patient is under our own immediate observation, strong alkalies, applied to the outer surface of the membrane and washed away immediately afterwards, sometimes remove thickened layers of epidermis, and stimulate the absorption of effused products.

3. Injuries of the Tympanic Membrane.

A traumatic lesion of the membrane may be the result of action directly upon the tissue of the membrane, or indirectly through the intervention of the bones of the head or of the air in the canal of the ear.

1st, Of the injuries acting directly on the membrane the most frequent are caused by objects such as a knitting pin, hair pin, tooth-pick, straw, or small twig, being forced into the canal of the ear and through the membrane. While, for example, a woman is engaged in knitting, she applies the point of the pin to the external meatus to relieve a feeling of itchiness, and the pin, from some accidental cause, such as a push from some one passing, is driven into the ear and through the tympanic membrane. Such an accident is attended by a loud detonation and by very acute pain in the ear, while the person may become faint and giddy. There is usually some escape of blood from the ear, and on examining the membrane we find the seat of the penetrating wound covered with blood. When we are able to get a complete view of the parts, we generally find that the wound is in front of the manubrium, and that around the aperture the membrane has a more or less dark red colour from extravasated blood. Cases are recorded of fracture of the manubrium resulting from such an injury. The membrane may also be wounded or even perforated by efforts to extract foreign bodies from the ear, by the improper use of the probe, by the point of a syringe with a long nozzle, when clumsily used, by severe syringing, and by long-continued pressure on the membrane of a foreign body or of an accumulation of hard cerumen. Dangerous injury to the membrane has been sometimes caused by boiling water, molten lead, and by caustic substances finding admission into the ear. Perforating wounds of the tympanic membrane often heal quickly by first intention, but they may be followed by inflammation and suppuration of the middle ear.

2nd, Rupture of the membrane, due to indirect violence, may be caused—(*a*) By sudden and great condensation of the air in the external auditory canal or in the middle ear; (*b*) By concussion or fracture of the bones of the head propagated to the membrane. Both of these causes may act simultaneously, as in the case of a severe blow on the side of the head. In all cases the membrane is more likely to give way, if it is already in a morbid condition, especially if it is atrophied, or if adhesions have formed with other parts, or if there be obstruction of the Eustachian tube, which prevents the force passing out by that channel.

Rupture of the membrane from sudden condensation of the air in the external auditory canal may arise from the sudden report of artillery in the vicinity of the ear. A diver, striking the surface of the water with the side of the head, may have his tympanic membrane ruptured by the sudden condensation of the air in the canal of the ears. Boxing the ears is a not infrequent cause of rupture of the membrane. Dr. Chimani, of Vienna, found that of 54 cases of rupture of the tympanic membrane, coming under his notice, 38 were due to this cause, and of these 36 were, as we might have expected, on the left side. Sudden condensation of the air in the naso-pharyngeal cavity, propagated to the air in the tympanum, may also rupture the membrane, especially if the latter is weakened by disease. In this way the membrane has been ruptured in severe paroxysms of coughing, especially in hooping cough, in inflation by Politzer's method or through the Eustachian catheter, and according to some authorities in death by hanging.

At the moment of rupture of the tympanic membrane the patient usually experiences a loud crack in the ear followed immediately by severe pain, by subjective sounds in the ear, by deafness, and sometimes by giddiness.

There may be considerable effusion of blood, not only into the external auditory canal, but also into the middle ear and through the Eustachian tube into the throat and nose. The blood may for some days prevent a full or accurate examination of the condition of the parts. When a perforation of the membrane has a traumatic origin, it is found that, by the Valsalva method, air is forced through the perforation with a very distinct blowing sound, heard by bystanders, the inflation being much more easily and completely effected than in perforations from disease. The tear in the membrane is most frequently found behind the manubrium or at the antero-inferior quadrant. The edges of the tear are not, as a rule, approximated, for the opening generally gapes and is oval or elliptical in form. Sometimes there is a flap inclining outwards or inwards. We often find ecchymosis in the neighbourhood of the rupture, and injected vessels along the manubrium. Inflammation and suppuration in the middle ear do not so often follow this form of rupture of the membrane, as in the case of direct wounds of the membrane. Within a week or two the opening heals, unless it has been injudiciously treated by irritating applications. If inflammation and suppuration do ensue, the parts generally recover in a few weeks, although occasionally the disease does take a chronic course. If the injury is limited to rupture of the membrane, the function of the organ is, as a rule, completely regained. Sometimes the subjective sounds in the ear continue for a long time, and more rarely they remain a permanent annoyance.

In addition to the rupture of the membrane, however, the nervous structure of the labyrinth may be injured by the concussion of the air or of the bones of the head. The deafness is greater, and the subjective sounds more distressing, while both are likely to remain permanently. If the membrane be not ruptured, the injury to the labyrinth may be even still greater, as the force, not being spent in tearing the tissue of the membrane, is exerted upon the chain of bones, which may be driven violently in upon the fluid of the labyrinth, and so injure the terminations of the auditory nerve.

The tuning-fork, applied to the bones of the head, is very useful in giving us information as to the presence or absence of injury to the labyrinth. If the vibrating fork, when in contact with the nasal bones or middle line of the head, is heard *better* on the injured side, the great likelihood is that no serious mischief has happened to the nerve structure in the labyrinth.

Rupture of the membrane, due to blows on the ear, may give rise to an action at law for damages. In the event of a legal inquiry the medical man should have the following points in view:—1st, After the first few days it is impossible to determine with certainty whether a perforation of the membrane has had a traumatic origin, or has been the result of a pathological process. 2nd, Several months must elapse after the injury, before we are able to say if permanent mischief to the structure and function of the organ remains behind. 3rd, It is very difficult to say whether the deafness or the subjective sounds, which may be complained of after an injury, may not be due to previous chronic disease in the middle ear, a condition which, in one ear or in both, affects a very large number of the population. 4th, If inflammation and suppuration follow the injury, it is within the range of possibility that very serious consequences, even death, may ensue. 5th, If there is evidence of labyrinthine mischief having resulted from the injury, deafness and serious noises in the ear may continue during the whole of the patient's life.

As is well known, fracture of the base of the skull is commonly attended by rupture of the tympanic membrane. In this case the tear is usually a continuation of a fissure made in the roof of the external auditory canal or in the roof of the tympanum. Usually copious bleeding takes place, partly from the vessels of the membrane and partly from the osseous tissue. The escape of blood, however copious, from the external auditory canal or nose after an injury to the head does not necessarily mean that there is a fracture of the base of the skull. A considerable quantity of blood may escape from the ear and nose, if the tympanic membrane is simply ruptured, or if there is tearing of the soft parts of the tympanic cavity or of the skin of the external auditory canal, without fracture of the osseous roof of the ear. We have already spoken of fracture of the tympanic plate of the external auditory canal being occasionally the source of bleeding from the ear (see p. 172).

The escape, in considerable quantity, of clear, slightly albuminous fluid, which continues flowing for a pretty long time, is a much more serious indication of fracture of the base of the skull than the escape of blood. This symptom, after an injury to the head, generally means that there is fracture along the upper surface of the petrous part of the temporal bone, through the roof of the tympanum, and of the osseous part of the external auditory canal, with rupture of the tympanic membrane, tearing of the meninges, and escape of the cerebro-spinal fluid. The escape from the ear, a day or two after the injury, of a smaller quantity of serous-looking fluid, perhaps mixed with blood, is not a true indication of a fracture. This fluid may be due to a catarrh of the middle ear, set up by the injury, with great fluid exudation escaping outwards through the fissure in the membrane. A basilar fracture of the skull does not necessarily involve a fatal termination; and, if the patient lives, a chronic purulent disease of the middle ear is likely to follow.

Treatment.—When the membrane has been torn or ruptured, meddlesome treatment should be avoided. Cotton should be worn in the ear to protect the exposed tympanum from injurious atmospheric influences. Syringing with water or pouring into the ear various kinds of fluids is more likely to excite purulent inflammation of the middle ear than to expedite healing. If inflammation or suppuration ensue, these must be treated in the manner to be described afterwards.

All persons should be warned against the use of sharp-pointed instruments to the external meatus for the relief of itchiness. Besides the danger of injuring the membrane, the practice is injurious to the canal of the ear. Syringing the ear should be done with care, and syringes with very long thin nozzles must not be used. When the membrane is softened by acute inflammation, the patient is to refrain from strong expiratory efforts. The importance of great caution in the removal of foreign bodies from the ear has already been fully spoken of. Before taking a "header," the diver should plug the ears with cotton, and he should take care not to strike the surface of the water with the side of the head. The same precaution of stopping the ears with cotton should be adopted by artillerymen or persons who are exposed to loud and sudden sounds.* Parents and teachers should be warned against inflicting chastisement by boxing the ears.

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* Dr. Cousin's ear-protectors (see *B. M. Journal*, Oct., 1883) are useful in guarding the ears against loud sounds or the entrance of water.

PART THIRD.

DISEASES OF THE MUCOUS TRACT OF THE EAR —THE MIDDLE EAR.

Chapter I.—Anatomy and Physiology.

Chapter II.—Non-Suppurative Diseases.

Chapter III.—Suppurative Diseases.

Chapter IV.—Consequences of Suppurative Diseases.

CLASSIFICATION OF DISEASES OF THE MIDDLE EAR.

FULLY eighty per cent. of the diseases of the ear, coming under the observation of the aural surgeon, have their seat or origin in the mucous membrane of the middle ear. Hence the affections of this part demand our most earnest attention.

These affections are catarrhal or inflammatory processes, of very various degrees of severity, in the mucous membrane of the middle ear, chiefly of the tympanic cavity. Although they may, therefore, be looked upon as merely degrees of the same morbid process, presenting phenomena which have much in common, and frequently passing one into another, it is necessary upon clinical and therapeutic grounds to recognize and classify several distinct forms. Our knowledge of the precise anatomico-pathological conditions present at all times in the ear does not yet enable us to form a classification which is thoroughly satisfactory.

They naturally fall into two large groups, this division being based upon two points, namely *the presence or absence of a discharge from the ear*, and *the presence or absence of a breach of continuity of the tympanic membrane.* This arrangement is convenient for practical purposes.

1ST GROUP.

Those with neither discharge from the ear nor perforation of the tympanic membrane.

1. ACUTE NON-SUPPURATIVE INFLAMMATION.
2. MUCO-SEROUS CATARRH.
3. CHRONIC ADHESIVE OR DRY CATARRH.

2ND GROUP.

Those attended by purulent or muco-purulent discharge from the ear with perforation or partial destruction of the tympanic membrane—

1. ACUTE SUPPURATIVE INFLAMMATION.
2. CHRONIC SUPPURATIVE INFLAMMATION.
3. CONSEQUENCES OF CHRONIC SUPPURATIVE INFLAMMATION.

The writer has used the term *catarrh*, when the inflammatory process is comparatively mild, probably confined to the superficial layers of the mucous membrane, and attended by little, or perhaps by no pain at all, while the tympanic membrane is not at all or only slightly hyperæmic. He has, on the other hand, employed the term *inflammation*, when the process is much more intense, probably involving the deeper layers or sub-mucous connective tissue, attended usually in the acute forms by pain, often of a very intense character, and by a markedly inflammatory state of the tympanic membrane. The catarrhal diseases not unfrequently pass into the inflammatory ones.

CHAPTER I.

ANATOMICAL AND PHYSIOLOGICAL DESCRIPTION.

UNDER the term Middle Ear (Fig. 63) are comprised—

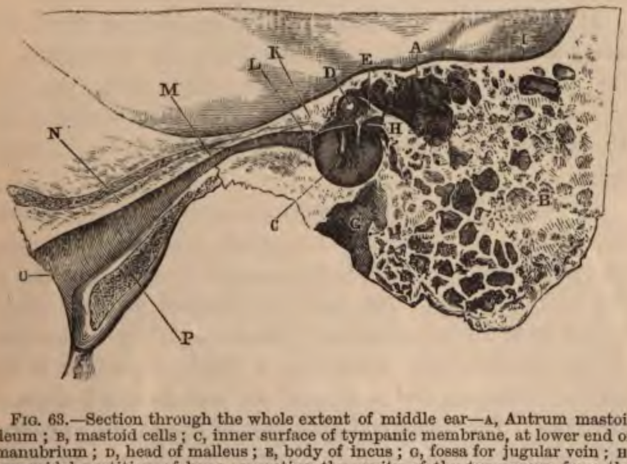

FIG. 63.—Section through the whole extent of middle ear—A, Antrum mastoideum; B, mastoid cells; C, inner surface of tympanic membrane, at lower end of manubrium; D, head of malleus; E, body of incus; G, fossa for jugular vein; H, pyramidal partition of bone separating the cavity of the tympanum from the antrum mastoideum. Below the letter H, a portion of the canal for the facial nerve is shown; I, dura mater; K, chorda tympani nerve; L, tympanic mouth of Eustachian tube; M, isthmus of the Eustachian tube; N and P, walls of cartilaginous part of Eustachian tube; O, pharyngeal mouth of Eustachian tube.

1st, A passage—the *Eustachian tube*; 2nd, A narrow cavity—the *Tympanum*; and, 3rd, A large number of small spaces

—the *Mastoid cells*. These three parts are in free communication with one another, and, by the Eustachian tube, with the naso-pharyngeal cavity, while they are shut off from the external auditory canal by the tympanic membrane. With the exception of a part of the Eustachian tube, they are filled with air, and their walls are everywhere lined by mucous membrane, which is simply a continuation of the mucous membrane of the pharynx. The walls are in great part composed of bone. There are four situations, however, where, instead of bone, there is soft and more or less yielding tissue, namely, 1st, the membrano-cartilaginous part of the Eustachian tube; 2nd, the tympanic membrane; 3rd, the membrane closing the fenestra rotunda; 4th, the annular band of the fenestra ovalis.

As the middle ear is in reality an offshoot from the naso-pharyngeal cavity, we shall begin its description at the pharyngeal mouth of the Eustachian tube, the real entrance to the middle ear, and after that consider the Eustachian tube, tympanum, and mastoid cells in their order.

Eustachian Tube.—The pharyngeal mouth of the Eustachian tube is found on the outer wall of the naso-pharyngeal cavity (Fig. 23) just behind the posterior end of the inferior spongy bone, and at a distance of about three inches from the outer orifice of the nose. It is an opening of considerable size, measuring a third of an inch in the vertical direction, and a fifth of an inch in the horizontal direction. The upper and back part of the circumference of this opening presents a thick rounded bulging formed by the projection of the end of the median cartilage. This bulging is an excellent guide to the introduction of the Eustachian catheter.

From this opening the Eustachian tube passes outwards, upwards, and backwards, forming an angle of 135° with the external auditory canal, till, at a distance of an inch and a half from the pharynx, it passes into the cavity of the tympanum. The walls of the third of the tube nearest the tympanum are formed of bone continuous with the upper part of the tympanic cavity. The tensor tympani muscle lies in an osseous canal, above and parallel with this part of the Eustachian tube.

The other two-thirds of the tube are formed partly of cartilaginous and partly of membranous tissue. The point of junction between this and the osseous portion is the narrowest part, and is hence termed the *isthmus.* Here the tube measures only two millimètres in diameter. The membrano-cartilaginous part, which measures an inch in length, is not a permanently open tube, such as the external auditory canal. At its pharyngeal opening, and at a point near to its junction with the osseous part, it is permanently open, but in the intervening part, the membranous wall lies in contact with the cartilaginous wall, the mucous surfaces being in contact with one another, the passage forming an S-shaped slit. This part of the Eustachian tube, indeed, forms a kind of valve, which, by opening and shutting, regulates the supply of air to the rest of the middle ear. A transverse section of the membrano-cartilaginous part of the tube shows a peculiar arrangement (Fig. 64). The inner and upper part of the circumference is composed of cartilage, which is of considerable thickness, and is usually described as consisting of two parts, although there is no natural division between them—1st, a triangularly shaped plate of cartilage, which is attached to the fibro-cartilaginous tissue at the base of the skull, and called the median cartilage—this forms the inner wall of the tube; 2nd, the smaller portion or hook-shaped cartilage, which bends round from the upper part of the median cartilage in a direction downwards and then inwards, like a bent hook. The circumference of the tube is completed in the outer and lower parts by membranous tissue. This extends from the lower aspect of the hook-shaped cartilage to the inferior end of the median cartilage. The fibres of the tensor palati muscle are attached to the whole length of the membranous part of the tube and of the lower part of the hook-shaped cartilage, the fibres of the muscle having a direction at right angles to the walls of the tube. The levator palati muscle lies under the floor of the tube, and its fibres are parallel with the canal.

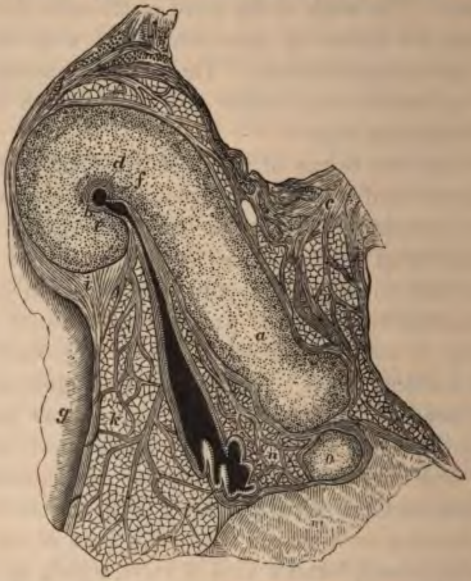

FIG. 64.—Cross section of lower third of membrano-cartilaginous part of Eustachian Tube—right ear (Rüdinger)—*a*, Median cartilage; *b* and *f*, folds of mucous membrane; *c*, fibro-cartilage at base of skull; *d*, the part of the canal enclosed by the hooked cartilage; *e*, end of the hook-shaped cartilage; *g*, the tensor palati muscle; *i*, attachment of the muscle to the cartilage; *k*, fatty tissue between the tensor palati and the membranous part of the tube; *l*, folds of mucous membrane in lower part of lumen of tube; *m*, levator palati muscle; *o*, isolated piece of cartilage lying below the lower end of the median cartilage.

The Tympanum.—From the outer or upper end of the Eustachian tube, opens the most important part of the middle ear—the tympanic cavity, tympanum, or "drum of the ear." This is a narrow space (Fig. 65 B) interposed between the tympanic membrane and the wall of the labyrinth.

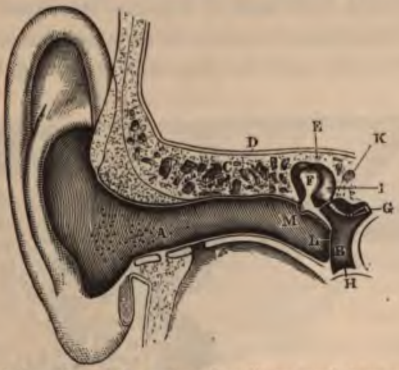

FIG. 65.—Vertical section of the external auditory canal, tympanic membrane, and tympanic cavity (right ear). For description of Fig., see p. 168.

Spanning this narrow space there is a bridge formed of three bones—the malleus, incus, and stapes—constituting an osseous connection between the tympanic membrane and the labyrinth.

The narrowest part of the cavity measures two millimètres or one-twelfth of an inch, and occurs between the tympanic membrane, at the lower end of the manubrium, and the inner wall. The widest part, measuring fifteen millimètres, extends from the opening of the Eustachian tube to the opening into the mastoid cells exactly opposite. From the roof to the floor, on a line with the manubrium, the cavity measures twelve millimètres.

The objects of interest in the tympanum may be well seen and studied by making a vertical antero-posterior section of the bone through the osseous part of the Eustachian tube, the cavity of the tympanum, and the mastoid cells. With a fine chisel and hammer a small gap is first made in the roof of the tympanum, the tendon of the tensor tympani muscle is next severed with a thin-bladed knife, and afterwards the stapes is separated from the incus. A very fine saw is then used to separate the inner part of the temporal bone from the outer or squamo-mastoid part. The outer half of the section (Fig. 66) shows—1st, The inner surface of the tympanic membrane with the anterior and posterior pouches; 2nd, The incus and malleus articulated together; 3rd, A small portion of the tendon of the tensor tympani muscle attached to the upper part of the manubrium; 4th, The chorda tympani nerve; 5th, The outer wall of the osseous part of the Eustachian tube; and, 6th, The interior of the antrum mastoideum and of a number of other mastoid cells.

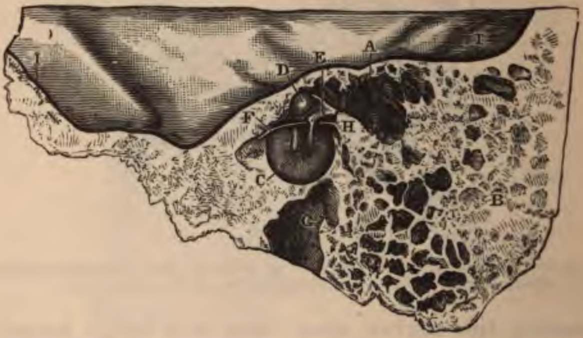

FIG. 66.—Inner aspect of the outer half of the temporal bone exposed by a vertical section made antero-posteriorly through the tympanum, antrum mastoideum, and other mastoid cells. A, antrum mastoideum; B, mastoid cells; C, inner surface of tympanic membrane; D and E, head of malleus and body of incus, forming the osseous partition dividing the upper tympanic space into two compartments—in the drawing the outer compartment is concealed by these two bones—F, chorda tympani nerve; G, fossa for jugular vein; H, pyramidal partition of bone separating the cavity of the tympanum from the antrum mastoideum. Below the letter H, a portion of the canal for the facial nerve is shown; I, dura mater.

The handle of the malleus is fixed into the membrane, as already described, while the head projects upwards and inwards, till its upper surface is close to the roof of the tympanum. The posterior surface of the head of the malleus is articulated to the head of the incus, whose long process extends downwards behind and parallel with the manubrium at a distance of two millimètres from the postero-superior quadrant of the membrane, but not extending so far down as the lower end of the manubrium. The short process of the incus passes backwards and slightly downwards to rest with its tip on the floor of the opening into the antrum mastoideum. It is to be noted that the upper half of the malleus and the body and short process of the incus are higher than the tympanic membrane, in what may be called the upper tympanic cavity. This upper tympanic cavity measures about six millimètres in height. The head of the malleus and the body of the incus are here articulated together in such a way as to form an osseous partition, incompletely dividing the space into an outer and an inner compartment, the inner being the wider of the two. On removing the incus, a fold of fibrous tissue is seen, covered with mucous membrane, extending between the upper part of the manubrium and the posterior wall of the tympanum near to the sulcus tympanicus. This fold forms the inner wall and the corresponding part of the tympanic membrane forms the outer wall of a space, open below, and named by von Tröltsch the *posterior pouch* of the membrane. There is a much smaller space in front of the manubrium—the *anterior pouch*. The chorda tympani nerve, coming from the facial nerve in the Fallopian canal, is seen forming the lower edge of the inner leaf of the posterior pouch; it then comes in close contact with the inner surface of the neck of the malleus, and after taking part in the formation of the anterior pouch it finally emerges from the tympanum by the

Glaserian fissure or petro-tympanic suture on its way to the tongue.

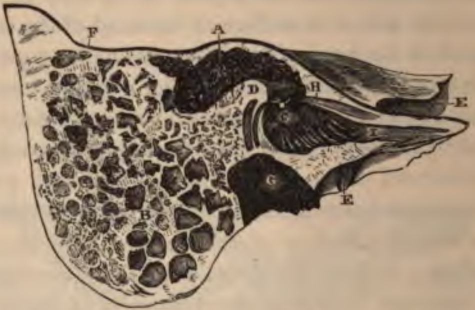

FIG. 67.—View of inner half of osseous part of middle ear exposed by same section as in last figure. A, Antrum mastoideum ; B, mastoid cells ; C, promontory on inner wall of tympanum—above is seen the stapes bone in its recess ; D, Partition between cavity of tympanum and antrum—below the latter is part of the canal for the facial nerve, and in front of this canal the stapedius muscle ; E, the carotid canal ; F, the dura mater ; G, the fossa for the jugular vein ; H, the belly of the tensor tympani muscle ; I, inner wall of the osseous part of the Eustachian tube

The other half of the section (Fig. 67) shows the inner wall of the osseous part of the Eustachian tube, the inner wall of the tympanum, the antrum mastoideum and a number of the other mastoid cells. On the inner wall of the tympanum are found the two openings closed by membranes, which separate the tympanum from the watery fluid of the labyrinth. These openings are the *fenestra ovalis* or opening into the vestibule and the *fenestra rotunda* or opening into the cochlea. The fenestra ovalis is in the upper and back part of the inner wall of the tympanum, at the bottom of a recess or niche, the *pelvis ovalis*. This recess is seen to accommodate the stapes, the footpiece of which is attached to the membrane, closing the fenestra ovalis, while its head, in the natural condition, articulates with the lower end of the long process of the incus. The slender crura of the stapes are separated by only a very small interval from the walls of the pelvis ovalis. The base of the stapes does not completely fill up the fenestra ovalis, there being a small space between the circumference of the footpiece of the stapes and the edge of the opening. This space is filled up by an annular band of fibrous tissue, lined on its inner surface by the periosteum of the vestibule, and on its outer surface by the mucous membrane of the tympanum. The fenestra rotunda, closed by the *membrana tympani secundaria*, is also situated at the bottom of a recess in the bone. This recess is lower down than that leading to the fenestra ovalis, at the postero-inferior part of the inner wall of the tympanum. It looks *backwards* and not outwards like the pelvis ovalis, and owing to this peculiarity the membrana tympani secundaria can never be seen from without even in complete destruction of the tympanic membrane. Only the anterior rounded edge of the opening leading to this recess is visible from the outside. Between and in front of the openings leading to these two fenestræ is the *promontory*, a smooth rounded prominence just opposite to the middle and anterior part of the tympanic membrane. It forms the outer wall of the first turn of the cochlea. In front of this the inner wall of the tympanum is thin and porous, and is continuous with the inner wall of the osseous part of the Eustachian tube. Behind and above the fenestra ovalis there is an elongated prominence constituting the upper wall of the pelvis ovalis. This is a part of the Fallopian canal—the osseous tube, which contains the facial nerve. At the uppermost and hindermost part of the inner wall of the tympanum a smooth white surface is seen marking the position of the anterior or horizontal semicircular canal. At the upper part of the inner wall of the tympanum, at the junction of the inner wall with the roof, there is seen a part of the slender osseous canal (not usually a complete canal) containing the belly of the *tensor tympani* muscle. This osseous canal extends above and parallel with the Eustachian tube, while, posteriorly just above and in front of the pelvis ovalis, it terminates in a process, round which the tendon of the tensor tympani muscle turns outwards so as to cross, in the natural conditions, the upper part of the tympanic cavity, and be inserted into the manubrium just below the neck of the malleus. Behind and below the entrance to the fenestra ovalis there is a conical osseous eminence—the pyramid—containing a canal for the *stapedius* muscle, for, like the tensor tympani, it is enclosed in a bony canal. This is the smallest striated muscle in the body, and its tendon is inserted into the posterior part of the head of the stapes. Behind the canal containing the stapedius muscle lies a part of the Fallopian canal.

The *roof* of the tympanum consists of a layer of bone of very variable thickness and density, which is lined on its upper surface by dura mater. The *floor* is also formed of a layer of bone of very variable thickness, and has a tesselated appearance, being thrown into many small depressions and ridges. It is at a somewhat lower level than the floor of the external auditory canal.

The Mastoid Cells.—A distinct opening in the upper part of the posterior wall of the tympanum, just opposite to the opening into the Eustachian tube, leads into the *mastoid cells*—the third division of the middle ear. The cell, which communicates directly with the tympanum, has received from its large size the distinctive name of *antrum mastoideum.* The upper tympanic space, to which we have already referred, passes directly backwards into this antrum mastoideum. The tympanum and antrum mastoideum are roofed in by one and the same lamina of bone, separating both spaces from the dura mater above. But, while they are continuous at the upper part, the lower two-thirds of these cavities are separated from each other by a thick pyramidal partition of bone, in consequence of which the floor of the antrum is at a much lower level than its opening of communication with the tympanum. This formation is very unfavourable to the escape of secretion collected in the antrum. The upper or narrow part of this partition is a rounded ledge, which forms the floor of the passage between the tympanum and the antrum, and on this ledge the short process of the incus rests. The antrum mastoideum is separated from the postero-superior wall of the inner end of the external auditory canal by only a thin layer of bone, which in purulent diseases of the antrum may be perforated by caries. The remaining numerous mastoid cells are of various sizes (Fig. 68), and are situated, in most part, lower down and more superficially than the antrum. The largest of them and the greatest number are found in the mastoid part of the temporal bone, but they occur also in various other parts of the temporal bone. They exist, for example, in the bone forming the *roof* and *floor* of the *tympanum*, in the roof of the osseous part of the external auditory canal, and also towards the apex of the petrous part of the temporal bone. In advanced years the cells often in great part disappear, and their interior is converted into dense, ivory-looking bone.

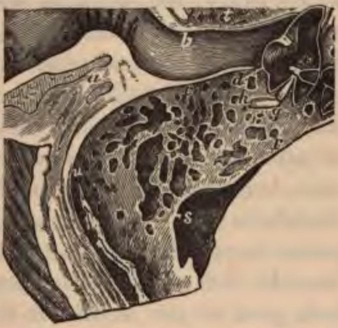

FIG. 68.—Horizontal section through the external auditory canal, tympanum, and mastoid cells, showing the relations of the latter to the two former (after Rüdinger). *a*, posterior cartilaginous wall of external auditory canal; *b*, external auditory canal; *c*, anterior wall of mastoid cells, or posterior osseous wall of external auditory canal; *d*, tympanic membrane; *f*, cavity of tympanum close to stapes; *g*, stapedius muscle; *h*, a portion of facial nerve; *r*, section of a semicircular canal; *s*, inner wall of mastoid cells, over the groove for the lateral sinus; *u*, outer wall of mastoid cells.

The mastoid cells are enclosed by a shell of compact bone, the cortical part. That which bounds the cells internally has the groove for the lateral sinus on its inner surface, while above, the cortical part is in contact with the dura mater, and in front it forms the posterior osseous wall of the external auditory canal. Externally it forms the convex surface behind the auricle. As the result of purulent disease in the mastoid cells fistulous openings often form spontaneously on this external wall of the mastoid cells, which is also the situation where artificial perforation is most frequently performed for the exit of purulent collections in the mastoid cells.

Peculiarities of the Middle Ear in Childhood.—The middle ear presents in the young child some peculiarities worthy of attention. The Eustachian tube is shorter, wider, more horizontal, and less cartilaginous. On this account the tube is more easily inflated in childhood, while secretion passes more readily from the tympanum to the pharynx than in the adult. The projection at the upper and back part of the mouth of the tube is also much less marked, and the pharyngeal opening is not so open, being more like a slit. In early childhood the mastoid cells, with the exception of the antrum mastoideum, are very slightly developed, the mastoid process being not only very small, but simply consisting of cancellated bone. The antrum mastoideum is, however, in childhood always well developed, and it occupies a more superficial position than in the adult. There is also often in childhood a very distinct fissure in the roof of the tympanic cavity. Through this fissure a process of dura mater, with vessels and nerves, passes down, and becomes continuous with the mucous membrane lining the tympanum.

Lining Membrane of the Middle Ear.—The walls and contents of the middle ear are everywhere lined by mucous membrane. We saw that the cutaneous lining of the ear became gradually thinner from without inwards, until over the outer surface of the tympanic membrane it became so thin as to be transparent. So the mucous lining of the ear, comparatively thick at the pharyngeal mouth of the Eustachian tube, becomes gradually thinner as it passes up, until over the walls and contents of the tympanum and the interior of the mastoid cells it is quite transparent. At the pharyngeal mouth of the tube the mucous membrane contains a large number of racemose glands, which are also found, but in less number, higher up. In the membranous part of the tube the mucous membrane is thrown into numerous folds. In the whole of the Eustachian tube and partly in the tympanum the membrane is provided with ciliated epithelium, the movements of the cilia being directed towards the pharynx. In the tympanum the extremely delicate mucous membrane covers the small bones, the tendons of the muscles, the fenestral structures and recesses—in short, the whole of the walls and contents of this cavity. Over the osseous walls and the small bones it is inseparably united to the periosteum, so that we must look upon every inflammation of this lining as having the gravity of a periostitis. The diseases of the middle ear are simply various grades of catarrh or inflammation of the mucous membrane, and the pathological changes, found in the different parts of the middle ear, causing disturbance to the function of the organ, are generally due to the effects of these catarrhal processes. In the Eustachian tube, the swelling and exudation frequently obstruct the canal, while agglutinations and adhesions may take place, and hinder the proper separation of the walls during swallowing. So in the cavity of the tympanum the swelling or thickening of the mucous membrane may cause adhesions between the outer and inner walls. Again, exudation of mucus, serum, or pus may partially or completely fill the cavity of the tympanum and even the mastoid cells, often leading to other and permanent changes. It is found, however, that the thickening, swelling, and hypersecretion of the mucous membrane covering the chain of bones, especially the stapes, and that lining the walls of the two recesses leading to the two fenestræ and the fenestral membranes themselves, are particularly injurious to the function of hearing. In this way the delicate movements of the bridge of bones, and more especially of the stapes, and the mobility of the structures closing the fenestræ are seriously disturbed. The mucous membrane lining the mastoid cells, especially the antrum mastoideum, generally shares to a greater or less extent in the catarrhal or inflammatory states of that lining the tympanic cavity, and in the case of the purulent inflammations this participation of the mastoid cells may lead to serious consequences.

The Relations of the Walls of the Middle Ear to Neighbouring Parts.—These are of very great importance in view of the effects which may result from purulent inflammation of the mucous membrane of the middle ear—a very frequent affection of the ear. The bony walls of the middle ear are at particular parts in direct contact with, or closely contiguous to, 1st, The dura mater and brain; 2nd, Large bloodvessels; 3rd, The facial nerve.

1st, The dura mater is separated from the mucous membrane of certain parts of the middle ear by thin bone. At one part this bony partition separates the roof of the tympanum and mastoid cells from the floor of the middle fossa of the skull, where rests the temporal lobe of the brain. At another part the bony partition separates the mastoid cells from the lateral and anterior part of the posterior fossa, where we find the concavity for the lateral sinus. These osseous partitions are never thick, and are frequently so thin as to be transparent. They are always perforated with apertures for connective tissue, vessels, and nerves, especially at the roof of the tympanum where there exists the squamo-mastoid suture. Again, in a considerable number of skulls, gaps caused by defective development are found in either or both of these partitions, so that at these gaps the dura mater and the mucous membrane of the middle ear are in direct contact. Through these two partitions inflammatory or purulent diseases of the middle ear may extend either by carious openings, or by the bloodvessels, or by direct contiguity of tissue, to the dura mater and brain. But there is another pathway, by which the inflammatory or purulent process may pass to the dura mater, namely, through the interior of the labyrinth. The cochlea may be invaded through the fenestra rotunda, or through a carious aperture in the promontory. The vestibule may be broken into by ulcerative disease, extending through the structures closing the fenestra ovalis. Caries of the extreme upper and back part of the inner wall of the tympanum may convey disease to the interior of the horizontal semicircular canal. The disease having reached the interior of the labyrinth is separated from the dura mater of the internal auditory canal only by the perforated lamella of bone, through which pass the fibres of the auditory nerve. Instances are also recorded, in which the disease passed from the tympanum to the internal auditory canal by the Fallopian canal and sheath of the facial nerve.

2nd, One of the main arterial trunks and three venous channels are in close proximity to, and only separated by thin osseous walls from, the mucous membrane of the middle ear. The *internal carotid artery,* contained in the carotid canal, lies on the other side of the inner wall of the tympanum and osseous part of the Eustachian tube. The great intracranial venous trunk, the *lateral sinus*, in its sigmoid groove, is separated from the mastoid cells only by the inner wall or cortical covering of the latter. Scarcely less important is the position of the *internal jugular vein* at its bulb exactly under the floor of the tympanic cavity, while of less, but yet of considerable importance, is the proximity of the *superior petrosal sinus*, which is situated upon the upper edge of the petrous part of the temporal bone near to the roof of the middle ear. The osseous partitions separating these vessels from the middle ear have the same peculiarities as the osseous partitions in contact with the dura mater. They may be thin to transparency, they may have gaps, and they are perforated by openings for connective tissue, vessels, and nerves. In purulent diseases of the middle ear any one of these blood channels may be involved. From the internal carotid fatal hæmorrhage has ensued, due to caries of the osseous partition. In the veins fatal issues from phlebitis, thrombosis, and pyæmia have not unfrequently been caused by purulent diseases of the middle ear. The positions of the internal carotid artery and of the internal jugular vein with reference to the middle ear also explain the sense of throbbing and the venous murmurs experienced in the ear by some persons.

3rd, We have seen the close connection of the facial nerve with the inner wall of the tympanum and the mastoid cells. The osseous partition separating the nerve from the mucous membrane of the middle ear is often extremely thin and sometimes defective, especially in its position above the fenestra ovalis. We meet with facial paralysis not only in purulent diseases, but also in simple congestions of the mucous membrane of the middle ear.

Function of the Middle Ear.—The various parts of the middle ear either directly or indirectly conduct sonorous vibrations from the tympanic membrane to the fluid of the labyrinth. The tympanum is engaged directly in the conduction of sound, while the Eustachian tube and the mastoid cells are indirectly concerned in the due performance of this function. While the air in the tympanic cavity and the membrana tympani secundaria are to some extent the media by which the vibrations of the tympanic membrane are transmitted to the fluid of the labyrinth, there is no doubt that the chain of small bones—the malleus, the incus, and the stapes—with the membrane closing the fenestra ovalis, forms the chief conducting medium between the tympanic membrane and the fluid of the inner ear. The chain of bones forms a delicate lever apparatus, which is placed, by the vibrations of the tympanic membrane, in a state not only of molecular movement, but also of movement *en masse* inwards and outwards. These movements are much more extensive in the malleus than in the stapes. According to the experiments of Dr. Buck, of New York, the extent of movement is twice as great in the malleus as in the incus, and twice as great in the incus as in the stapes. The labyrinth is protected in this way against the effects of great concussions in the neighbourhood of the ear, or of undue inward pressure of the tympanic membrane. On the other hand, when the air in the middle ear is abnormally compressed, and the tympanic membrane thereby forced outwards, the excessive withdrawal of the stapes from the fenestra ovalis is hindered by the structure of the joint between the malleus and the incus. This is furnished with a "catch," which limits the movement outwards of the long process of the incus, and renders it much less than that of the malleus. The movements of the base of the stapes are very limited. According to Helmholtz, when the membrane is moved outwards and inwards by alternate condensation and rarefaction of the air in the external auditory canal, the movements or excursions of the stapes do not extend over more than an eighteenth to a fourteenth of a millimètre. In the movements excited by sonorous vibrations, the excursions of the stapes are extremely short, in very weak yet clearly perceptible tones they escape recognition even by a powerful microscope. The vibrations probably become strengthened in passing from the comparatively large tympanic membrane to the much smaller membrane closing the fenestra ovalis.

By the free passage of air through the Eustachian tube, the atmospheric pressure is always the same on both sides of the tympanic membrane. This ensures a proper degree of tension of the membrane and ossicular chain, which is essential to the healthy condition of the ear. Whenever there is a hindrance to the due passage of air through the Eustachian tube, the tension is disturbed, because, the air in the tympanic cavity becoming more rarefied than the air on the outer surface of the tympanic membrane, the latter is pressed unduly inwards, and its tension as well as that of the whole chain of bones is increased. It has been pointed out that, in ordinary conditions, the greater part of the membrano-cartilaginous tube is closed. It opens, however, every time we perform the act of swallowing; and it is found that air may pass from the naso-pharyngeal cavity to the tympanum at other times also. During ordinary breathing the tympanic membrane in some persons moves synchronously with inspiration and expiration, but probably in these cases the tube is unusually wide and open. In forced expiratory efforts, as coughing, singing, blowing the nose, &c., the air may pass through the Eustachian tube to the cavity of the tympanum. If the nasal passages are closed from any cause, these expiratory efforts have a greater effect in forcing air through the Eustachian tubes. The width and permeability of the Eustachian tubes undoubtedly vary much in different persons and even in the same person in different circumstances, such as the state of the weather, &c. Fluid secretion in the tympanic cavity may, in certain circumstances, escape through the Eustachian tube to the nasal passages, but the situation of the tympanic opening of the tube at the *upper* part of the tympanum is unfavourable to its function as an exit tube. Besides imparting lightness to the thick temporal bone, the air-filled mastoid cells act as resonance chambers to the tympanic vibrating structures and thus intensify the sound, while they also form a reservoir for supplying the tympanum with air, in partial or temporary obstruction of the Eustachian tube.

Functions of the Four Muscles of the Middle Ear.—The tensor palati or circumflexus palati is the chief means of opening the Eustachian tube. From the direction and attachment of the fibres, already referred to, it is clear that when this muscle contracts, as it does during the act of swallowing, the outer or membranous wall, with the hook-shaped cartilage, is withdrawn from the inner wall. As this muscle seems to have no action on the soft palate, its action being confined to the Eustachian tube, von Tröltsch suggests that it be named the abductor or dilatator tubæ. The tensor palati receives its nervous supply through the otic ganglion from the motor fibres of the fifth nerve (internal pterygoid).

The levator palati muscle has a much less important action on the tube, being chiefly a palate muscle. During contraction it forces the floor of the tube upwards and backwards, and in this way increases the transverse diameter of the tube. It is supplied by a branch from the pneumogastric nerve and also one from Meckel's ganglion.

The tensor tympani muscle in contracting pulls the handle of the malleus inwards, and thus increases the tension of the tympanic membrane The inward movement of the malleus is communicated to the long process of the incus, and the stapes is thus pressed in upon the labyrinth. The tendon of this muscle is apt to become abnormally and permanently shortened, when the tympanic membrane has continued for a length of time in an indrawn position, and the contracted tendon may resist any efforts made to restore the tympanic membrane and ossicular chain to their proper position and degree of tension. It receives its nervous supply from the same source as the tensor palati.

The stapedius muscle is understood to have an action antagonistic to that of the tensor tympani. It prevents the stapes being unduly forced into the fenestra ovalis. It derives its nerve supply from the facial nerve in the Fallopian canal.

The function of these two muscles therefore is to regulate, in some degree, the tension of the tympanic membrane and ossicular chain, and thus to preserve the due amount of pressure of the stapes upon the fluid of the labyrinth.

Some writers describe another muscle—the Salpingo-pharyngeus—as acting upon the tube. Good authorities, however, look upon this as merely a fascia. If muscular, it may be considered as contributing to the fixed position of the median cartilage.

CHAPTER II.

NON-SUPPURATIVE DISEASES OF MIDDLE EAR.

I. Acute Non-Suppurative Inflammation of the Middle Ear.

Syn.—Acute Inflammation of the Middle Ear—Otitis Media Acuta (*Politzer*); *Acute Simple Catarrh* (*von Tröltsch*); *Acute Catarrhal Inflammation of the Middle Ear* (*Roosa*); *Acute Non-Perforative Inflammation of the Middle Ear.*

Pathology.—In this disease the mucous membrane, especially of the tympanic cavity, is in a state of congestion, swelling, and hypersecretion. The secretion is chiefly mucous or muco-purulent, with occasionally an admixture of blood. While the tympanic membrane generally shares very much in the inflammatory process, it is neither ulcerated nor perforated. The disease is most frequently limited to one ear; but the one ear may be affected after the other.

Causes.—It is most frequent in childhood. The most common causes are:—1. Extension of an acute catarrh from the nasal and pharyngeal mucous membrane. 2. The direct action of cold air or water upon the ear or head. 3. The exanthematous diseases. (See Chapter on Causation.)

Subjective Symptoms.—The first symptom usually complained of by the patient is a sense of heat, fulness, and pressure in the ear. Very soon the sensation becomes that of distinct pain, often becoming most intense and penetrating. The pain is felt not only in the ear, but shooting from that along the side of the head sometimes to the forehead or to the shoulder. The pain may be less intense during the day, generally becoming very much worse at night, during the whole of which no rest at all may be obtained. It is usually aggravated during the acts of swallowing, hawking, coughing, blowing the nose, &c. In severe cases the mastoid process is tender on pressure. The patient also complains of a painful hammering or throbbing in the ear, which can be removed by pressure on the carotid of the same side. Subjective sounds in the ear, especially those of a ringing or hissing character, are frequently present, while after a few days bubbling or crackling sounds are heard in the ear, especially during swallowing or blowing the nose. The patient's own voice sounds to himself with increased resonance on the affected side, just as with the healthy ear, when it is closed with the finger.

There is usually very considerable loss of hearing, especially after exudation takes place. The defect of hearing is most marked when the swelling of the mucous membrane or the exudation is very great, and especially when they take place in either of the three following situations—1st, The ossicular chain; 2nd, The fenestral recesses; or, 3rd, The Eustachian tube. When the labyrinth shares decidedly in the congestive process, the defect of hearing may be extreme. The disease is occasionally ushered in with a distinct attack of giddiness, which may also be set up by the pressure of the inflammatory products upon the walls of the middle ear.

The subjective symptoms of catarrh of the nasal and pharyngeal mucous membrane may be experienced, such as pain during swallowing, sense of stopping up in the nasal passages, dry mouth, &c.

There may also be present considerable feverish disturbance, with stupor or delirious excitement.

In young children the disease may be manifested by great restlessness, by apparent difficulty in sucking and swallowing, and by screaming when the ear is touched or pressed upon. Great disturbance of the nervous system, such as convulsions or coma, is undoubtedly sometimes excited in the young child by an acute inflammation in the middle ear. This might be expected from the anatomical connection between the mucous membrane of the middle ear and the dura mater, which exists in childhood (see p. 264).

Objective Symptoms.—In some cases of acute inflammation of the middle ear the changes in the tympanic membrane are similar to those in acute myringitis (see p. 236). In mild cases the normal colour of the membrane has a red tinge, which is produced by the congested mucous membrane forming the inner layer of the membrane. For a short time the membrane has the appearance of a plate of polished copper. In other cases the vessels of the cutaneous layer of the membrane are markedly injected, especially over the membrana flaccida, the manubrium, and the periphery of the membrane. The other parts may at the same time have a leaden, grey, dull and lustreless appearance. In severe forms of the disease the individual vessels of the membrane can be no longer distinguished, and the whole surface of the membrane assumes a bright or a dull red colour.

With the stage of exudation the aspect of the membrane changes, owing to its being bulged outwards by the secretion in the cavity of the tympanum, or to interstitial exudation in the membrane, which is most frequent below its epidermic lining. The manubrium is no longer visible owing to the congested cutis and swollen macerated epidermis, which cover it. In some cases the superficial layers of the membrane may be thrown off in thick plates. Instead of a general bulging outwards of the membrane there may be partial bulgings, such as in the second stage of acute myringitis (Fig. 69). The colour of such bulgings varies in different cases; most frequently they are yellowish or reddish grey, but sometimes they are greenish and at other times bluish in colour. Saccular bulgings, which are yellowish grey or green in colour (Fig. 70), projecting from the upper and back part of the membrane, may overlap and cover the manubrium, while the rest of the membrane may be but little altered from the normal condition. These saccules sometimes consist of small collections of mucus or pus in the tissue of the membrane but communicating with the cavity of the tympanum. In some cases, and more particularly where the membrane has been already thickened from previous disease, there may be but little change in the membrane denoting the presence of exudation in the tympanic cavity. The skin of the external auditory canal at its inner end usually participates to a greater or less degree in the inflammatory process, while the mucous membrane of the nasal passages and pharynx is often reddened and swollen.

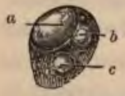

FIG. 69.

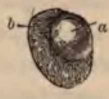

FIG. 70.

FIG. 69.—Appearance of right tympanic membrane in second stage of acute myringitis —*a*, large interlamellar abscess at upper and back part of membrane; *b* and *c*, smaller interlamellar abscesses.

FIG. 70.—Saccular bulging projecting from the upper and back part of the left tympanic membrane in acute inflammation of left middle ear — *a*, bulging; *b*, inflamed membrane in front.

Course.—Usually in from four days to a week the pain and the more marked inflammatory appearances of the membrane begin to pass away; but a greater or less degree of deafness and a dull heavy feeling in the ear may continue, even in favourable cases, for three or four weeks. During this time crackling sounds are sometimes heard in the ear, especially during swallowing or blowing the nose, when they are due to the separation of the walls of the Eustachian tube, and these sounds are frequently attended by more or less improvement in the hearing. The deafness occasionally passes off completely with a loud crack, described by some patients as being like the report of a pistol; as a rule, however, the improvement of the hearing after such a sound is only temporary.

When the acutely inflammatory stage passes away, the tympanic membrane assumes a yellowish grey or sometimes a leaden colour with, at certain points on its surface, a moist-looking appearance. In the greater number of cases, however, the membrane recovers, in the course of three or four weeks, its normal aspect and polish. As long as any secretion remains in the tympanic cavity, we may find a number of small separate vessels radiating from the centre to the periphery of the membrane. A somewhat hyperæmic state of the manubrium and of the vicinity of the short process is probably the last objective symptom to disappear. Rupture of the membrane with escape of serum or mucus occasionally takes place, but such a perforation usually heals up almost immediately.

Consequences.—Acute non-perforative inflammation of the middle ear may lead to permanent swelling and thickening of the mucous membrane with the inspissation of secretion. As the result of repeated attacks of the disease, or even of a single attack, there may be laid the basis of permanent changes in the tympanum and Eustachian tube, changes which will come to be considered under the heading of chronic dry catarrh of the middle ear. In this way deafness increasing gradually over years, and attended by distressing tinnitus aurium, may have its origin in one or several attacks of this disease.

Diagnosis.—If an objective examination is carried out, acute non-perforative inflammation can only be confounded with acute purulent inflammation of the middle ear or with acute myringitis. From the former it can only be distinguished by the course of the disease. If rupture of the membrane takes place with discharge of purulent or mucopurulent secretion, the case is one of acute purulent inflammation. The points by which we may distinguish it from acute myringitis have been noticed at page 238.

When, as is too frequently the case, no examination is made of the interior of the ear, acute non-perforative inflammation may be readily overlooked, and the disease may be confounded with some other condition. The pain in the ear is sometimes looked upon, especially in children, as toothache or as neuralgia connected with diseased teeth. This mistake may lead to serious blunders in treatment, such as the prescribing of quinine, a medicine which would probably act injuriously in acute inflammation of the middle ear. A large number of the so-called earaches, without discharge of matter from the ear, are really cases of this disease.

Acute non-perforative inflammation of the middle ear is undoubtedly sometimes looked upon as meningitis, or congestion of the brain. If the physician trusts to subjective symptoms alone, it is easy to see how, especially in the case of a child, such a mistake may be made. The pain which, even in an adult, may be described as being more in the side of the head than in the ear, the giddiness, the stupor or delirium, the convulsions, may readily, in the absence of objective examination of the ear, be regarded as pointing to inflammation in the interior of the cranium. The impairment of hearing, being usually limited to one side, may pass unnoticed, and thus no suspicion of aural disease may be entertained. When the inflammation occurs during an exanthematous disease, especially during scarlet fever, it is particularly liable to escape detection, and the symptoms which have been mentioned are likely to be attributed to the action of the specific poison. It is to be remembered, however, that an inflammation of the mucous lining of the middle ear may extend in the child to the membranes of the brain through the petro-squamosal fissure.

Prognosis.—In a strong healthy person, who has had previously no affection of the ear, and who lives under good hygienic conditions, and receives proper treatment, the recovery from acute non-perforative inflammation is usually complete in from two to three weeks. After the exanthemata it is likely to be more protracted than when the disease is simply due to cold.

Treatment.—In deciding upon the kind of treatment to be adopted, we must have regard to the severity and the stage of the disease. In a severe attack, signalized by great pain, local abstraction of blood is of great value especially in the early stage (see p. 103). In an adult four leeches should be applied—two over the tragus and two below and behind the lower part of the auricle. If the symptoms be less acute, one in each of these situations will suffice. In a young child one leech applied over the tragus will afford sufficient depletion. While it is questionable whether the inflammatory process is really checked by local depletion, there can be no doubt that the pain and throbbing in the ear are usually decidedly alleviated. The artificial leech of Heurteloup may be conveniently employed. In mild cases, where the pain and subjective symptoms are slight or of short continuance, local bleeding is unnecessary.

Warm applications are of great service in allaying the pain. A sponge or piece of folded lint pressed out of hot water, placed closely over the ear, and covered with impermeable material, as jaconet or gutta percha tissue, has often a very soothing effect. Breathing into the ear and holding the side of the head over hot water so as to allow the steam to pass in are simple and useful remedies. A small plug of cotton wool squeezed out of a warm solution of morphia

(f. 43) and inserted into the outer canal of the ear has sometimes a soothing effect. At other times a few drops of a sedative solution such as f. 12 placed on a pellet of cotton wool, and laid in the outer orifice of the ear, forms a convenient sedative application. It is desirable to prevent, if possible, softening and bursting of the membrane, and therefore poultices, or the pouring into the ear of warm liquids, which tend to soften the membrane, should in most cases be avoided. If, however, the membrane presents the distinct appearance of pointing, the poultices and the warm water will accelerate the rupture with advantage. Soothing embrocations containing belladonna, aconite, chloroform, or opium, applied to the neighbourhood of the ear (see f. 13), will assist in allaying the pain, which extends along the temple and side of the head.

In some cases, where the pain is not relieved by the foregoing remedies, and is of such an intense nature as to prevent sleep, an internal sedative may be required, such as a full dose of the solution of the muriate of morphia for an adult, or a dose of Dover's powder for a child. In an adult the subcutaneous injection of morphia may sometimes be called for. In order to prevent the action of cold air, loud sounds, &c., upon the inflamed organ, a plug of cotton wool should be worn in the ear, with a pad of cotton wool covering the auricle, while the inflammatory process is present. During winter time, and especially if there is cold wind, a plug of cotton should be kept in the ear for a time after the attack has passed off. When there is much feverish disturbance, general constitutional treatment is of importance. The warm bath or medicinal diaphoretics may, if they produce free action of the skin, tend to abate the inflammatory process. A saline laxative will also act beneficially.

Rest and quiet in the house conduce very much to a favourable issue, especially during winter or cold weather.

Recurrence of the disease is often due to exposure and fatigue. In the case of an infant, perfect quietness, absence of strong light, rest in a comfortable position, and the avoidance of pressure on the affected side are precautions which should not be neglected. If cerebral symptoms arise, appropriate remedies should be employed, such as bromide of potassium, cathartics, the application of cold to the head, &c. We must be careful to prevent the trickling of cold water into the ear from cold water applications to the head.

The nasal and pharyngeal mucous membrane should also be treated, if any morbid condition exists (see Part I., Chapter III.). Inflation of the middle ear is of great importance in improving the hearing and relieving the subjective sounds and the sensations of fulness and numbness in the ear. In the early stage of the inflammation, when the pain is very acute, inflation may aggravate the disease. When, however, the pain has become less severe but the deafness more marked, owing to the exudation in the cavity of the tympanum, the use of Politzer's method of inflating the middle ear is generally very beneficial both in improving the hearing and mitigating the unpleasant sensations. At first the pressure upon the air-bag should be moderate; but, as the acute inflammatory symptoms completely pass off, and if no pain is excited by the inflation, a greater amount of pressure may be employed. If the improvement in the hearing continues for only a few hours after inflation, Politzer's method should be repeated every day for a few days, and then, when the improvement continues for a longer period, the interval should be extended to every second day, and afterwards to twice a week, until complete recovery of the hearing is established. This in most cases will be achieved in about four weeks, supposing no disease has previously existed in the ear.

For this form of inflammation of the middle ear incision of the tympanic membrane is not, as a rule, to be recommended, unless in the very late stages, when a muco-serous exudation may persist in the tympanic cavity after all the acute symptoms have disappeared. In the earlier stages, incision of the membrane is liable to set up a prolonged muco-purulent discharge difficult to cure. At this stage, therefore, incision should only be practised, if a distinctly pointing yellowish bulging presents itself along with extremely painful symptoms, which do not abate under the treatment already described.

II. Mucous or Muco-Serous Catarrh of the Middle Ear.

Syn.—Catarrh of the Middle Ear (Politzer); Otitis Media Catarrhalis; Obstruction of the Eustachian Tube.

Pathology.—In this form of inflammation the hyperæmia and swelling of the mucous membrane are less severe and more superficial than in the acute non-perforative form, while the secretion consists of mucus or serum or both combined. The catarrhal condition is sometimes limited to the Eustachian tube, either simply at the pharyngeal opening or over the whole of the cartilaginous part. When limited to the Eustachian tube, it is sometimes called tubal catarrh or "obstruction of the Eustachian tube." More frequently, however, the morbid process extends to the lining membrane of the tympanic cavity and even to the mastoid cells. There is rarely spontaneous perforation of the tympanic membrane; and, if there is, the opening, after giving exit to some mucus or serum, soon heals up, seldom leaving a trace behind.

Causes.—This affection is most frequently found in children, when it is, in many cases, associated with adenoid vegetations in the upper pharyngeal cavity. It often originates in acute and still more frequently in chronic catarrh of the nasal and pharyngeal mucous membrane. In some persons a slight form, perhaps confined to the pharyngeal opening of the Eustachian tube, occurs during every cold in the head.

The exanthematous diseases, especially measles, are frequent causes. Children of strumous diathesis are more liable to it; and it occasionally arises from syphilitic disease of the throat. (See chapter on the causation of ear diseases).

Subjective Symptoms.—Pain is seldom complained of in this affection; occasionally, however, slight earache is experienced. In the slighter forms, when the catarrhal process is limited to the pharyngeal end of the Eustachian tube, the symptoms complained of by the patient may be no more than a sense of fulness and pressure in the ear with slight impairment of hearing and tinnitus. He has also usually a sense of crackling when blowing the nose. In this localized catarrh of the middle ear, which is often connected with a simple "cold in the head," the symptoms generally pass off in a few days.

In more pronounced forms, when the process extends to the tympanic cavity, although the defect of hearing is much greater, the sense of pressure or fulness in the ear is often less marked. If both ears are affected, the deafness may be so considerable that very loud speaking close to the ear is necessary to enable the patient to understand. The hearing varies, however, in different cases as well as in the same person at different times. These fluctuations, which are often very sudden, may be due either to changes in the permeability of the Eustachian tube disturbing the tension of the tympanic membrane and ossicular chain, or to changes in the position of the exudation, or in the degree of swelling of the mucous lining of the tympanum. The deafness is most marked, when the exudation or swelling affects the ossicula and fenestral structures. The sudden opening of the tube from subsidence of the swelling of its mucous membrane or from the expulsion of a plug of mucus is often attended by a crack in the ear, after which the hearing may be very acute for a time. The dulness, however, usually soon returns accompanied by a sensation, which the patient sometimes compares to the shutting of a valve.

The perception of sound by osseous conduction is, in uncomplicated cases, markedly increased. If the catarrh is limited to one side, the vibrating tuning-fork applied to the median line of the head is heard with much greater intensity in the affected ear than in the normal one. The patient has often the sensation as if the whole of the sound were heard on the deaf side. If the tuning-fork is heard better on the normal side, and if a distinctly catarrhal process exists in the other ear, there is probably a concomitant affection of the labyrinth, which will be found most frequently to be of a syphilitic character. A benumbed sensation over the side of the head and affected ear is often complained of. The patient sometimes complains very much of the sense of increased resonance of his own voice, which has been compared to the sensation felt while speaking with the head in an empty cask (Politzer).

Subjective sounds in the ear are not at all constant phenomena. Cracking sounds are, however, often heard, particularly on swallowing or blowing the nose, and arise from the passage into the tympanum of air through the Eustachian tube, when its partially agglutinated walls separate from one another.

Occasionally patients complain of heaviness, confusion, and diminished power of mental work, while sensations of temporary giddiness are sometimes experienced. Children, on the other hand, who have catarrh of the middle ear, are not unfrequently observed to be dull, disinclined for play, capricious, and ill-humoured.

Objective Symptoms.—The appearance of the tympanic membrane presents many varieties. In cases where the Eustachian tube has been for a time impermeable to the passage of air the position of the membrane is very characteristically changed (Fig. 71). By the rarefaction of the air in the tympanic cavity the pressure of the atmosphere on the outer surface of the membrane is no longer counterbalanced by an equal pressure on the inner surface, the result being that the membrane is forced *inwards*, and its outer concavity, especially at the centre, is markedly increased. This change in the curvature of the membrane is shown most clearly by the altered position of the manubrium, which is tilted inwards, upwards, and slightly backwards, and appears perspectively as if shortened. While the handle of the malleus is thus tilted inwards and upwards, the short process projects strongly towards the external canal, frequently resembling a white pointed peg (Fig. 71, *a*), and the folds passing from this are rendered more tense and prominent, especially the posterior fold, which appears like a white projecting ledge or ridge. If the inward bulging of the membrane is extreme, the lower half may present a convex appearance due to the membrane at that part lying in contact with the promontory, while the anterior rounded edge of the entrance to the fenestra rotunda may be seen behind and below. The cone of light is usually absent, but we often find a dark line, like a fine fold, extending parallel with and a short distance from the

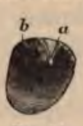

FIG. 71.

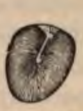

FIG. 72.

FIG. 71.—Indrawn tympanic membrane caused by obstruction of the Eustachian tube. *a*, short process of malleus with the indrawn manubrium below; *b*, part of stapes connected with long process of incus—both seen through the membrane lying closely over them.

FIG. 72.—The same tympanic membrane after inflation by Politzer's method.

antero-inferior periphery of the membrane. The normal grey colour of the membrane has frequently a violet or reddish tint, derived from the reflection of the hyperæmic lining of the tympanum. The long process of the incus and the head of the stapes are frequently seen through the membrane, especially if the latter is pretty thin and transparent at the upper and back part. After effective inflation the indrawn membrane, if not bound down by adhesions, &c., undergoes a striking change (Fig. 72). The manubrium and the short process with the folds passing from it return partially or completely to their normal position, and the membrane may even bulge outwards on each side more than in the natural state, so that the manubrium lies in a furrow. The vessels of the manubrium become for the moment more injected, and the colour of the membrane again becomes distinctly grey, while fine vessels are often perceived radiating from the centre to the circumference, and the parts within the tympanic cavity, which may have been previously visible, now disappear from view.

Along with this indrawn position of the membrane, although frequently also with a normal state of its curvature, there may be signs of *fluid exudation* in the cavity of the tympanum. If the membrane is fairly transparent, and the exudation only partially fills the cavity of the tympanum, the presence of this exudation is clearly shown through the membrane. A line, sometimes light coloured but generally dark grey or even black, is seen corresponding in position with the upper surface of the exudation (Fig. 73). This line may cross the membrane from side to side, and may be convex, concave, or wavy, or it may extend only over a portion of the membrane, such as from one side of the manubrium to the periphery. Below this line the membrane has usually a darker and sometimes more yellowish colour than above, from the exudation behind it.

If the exudation in the cavity of the tympanum be very thin this line may change its direction, when the patient's head is moved backwards or forwards, from the changes in position of the thin exudation; while, after inflation, a number of small circles, with dark well-defined outlines, may be seen through the membrane (Fig. 74). These are air bubbles produced by the mixing of the air with the exudation, and on inspection of the membrane they may be seen to move briskly during the inflation. After inflation the part of the membrane corresponding with the exudation behind may become more transparent, or on the other hand it may become more of a yellowish or bluish grey colour.

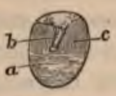

Fig. 73.

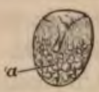

Fig. 74.

Fig. 73.—Exudation in cavity of tympanum, seen through transparent tympanic membrane—*a*, exudation; *b*, middle of manubrium; *c*, membrane in front of manubrium.

Fig. 74.—Air bubbles seen through tympanic membrane immediately after inflation in case of fluid exudation in cavity of tympanum—*a*, air bubbles.

Sometimes the presence of exudation is shown by a roundish well-marked bulging outwards, situated generally in the upper and back part of the membrane (Fig. 70). This bulging is most frequently yellowish grey or greenish yellow in colour, more rarely whitish. Probably in these cases the membrane at the bulging part undergoes a softening and thinning process, so that it yields to the pressure of the secretion. The bulging is sometimes found to appear only after inflation of the middle ear. This is particularly the case when exudation exists in the cavity of the tympanum, and a portion of the membrane is atrophied (see p. 289). After inflation, yellowish secretion may often be seen behind the atrophied and now bulged part of the membrane.

When the secretion fills all the part of the tympanum opposite the tympanic membrane, the signs of its presence exhibited by the membrane are less distinct. If the membrane is not opaque and the exudation is yellowish or wine-coloured, a more or less greenish yellow glitter is seen, and the membrane may have a more moist shining appearance than in the normal state. Inflation sometimes helps us in this case to distinguish the existence of the secretion. After inflation the colour may become much more yellow, and a bulging may be perceived at some particular part of the membrane, especially behind the umbo, giving at once the impression of a fluid collection.

If, as is frequently the case, the membrane is not sufficiently transparent to admit of the contents of the tympanum being seen through it, the signs of fluid exudation in that cavity are much less reliable. This insufficient transparency may be normal to the individual, or it may have been caused by the long continuance of the catarrhal process. When the membrane is not completely obscured, illumination with the sun's rays reflected from a flat mirror will help us to make out the presence or absence of exudation in the tympanum. If the membrane is completely opaque, simple inspection will not help us much. If, however, moist crackling is heard by auscultation during inflation, and if there is decided improvement of the hearing immediately after, there is great probability of the existence of exudation. The crucial test, however, if we are in doubt, is to puncture the membrane, an operation which may be performed with almost certain safety.

Course.—When the catarrh is due to an acute naso-pharyngeal attack, and limited to the pharyngeal mouth of the tube, the swelling and hypersecretion usually pass off under suitable treatment in from a few days to two weeks, with complete restoration of the hearing. When, on the other hand, the disease is the consequence of chronic catarrh or adenoid vegetations in the upper pharyngeal cavity, or when there exists in the individual a catarrhal tendency of the mucous lining of the middle ear, the disease is apt to run a very much more prolonged course, and improvement is liable to be interrupted by relapses. The affection may in these cases go on for years, especially in childhood, becoming more aggravated during winter and spring, and improving again in warm dry weather. It is found, however, that the catarrhal process tends to pass off at the age of fourteen or fifteen years, although the results may injuriously affect the organ during the whole future life. The character of the exudation has also an important influence on the course of the disease. When it is thin and serous, its absorption by nature or its complete removal by operation is more certain and rapid than when it consists of viscid stringy mucus.

As the result of severe exposure to cold or even of the irritation caused by mucus in the tympanum, the catarrhal process may become changed in character, and we may have acute suppurative inflammation.

Consequences.—The catarrh may exist for years without producing more than swelling of the mucous membrane and fluid exudation, an ultimate cure resulting without any injurious after-effects. In other cases changes take place either during the stage of secretion, or more generally they become developed after this stage has passed off. 1st, The long-continued indrawn or "sunken" condition of the membrane, due to the impermeability of the Eustachian tube, may lead to important and permanent consequences. The abnormally increased tension of the membrane leads in time to thinning or *atrophy* involving a part or even the whole of the membrane. The atrophied part, from being abnormally thin and flaccid, is depressed below the healthy membrane; it is also darker in colour, and its borders are sharply defined from the normal membrane. The interior of the tympanum, opposite the atrophied part, is sometimes seen as distinctly as if nothing intervened (Fig. 75). When we inflate the middle ear, or employ suction with Siegle's speculum, the atrophied part bulges out, sometimes like a small bladder, but the bulging soon disappears (Fig. 76). Even after the Eustachian tube has again become freely permeable the atrophy remains, and, while inflation of the middle ear by Politzer's method or Valsalva's experiment causes it to bulge out, and temporarily improves the hearing, it is found that in a few hours the atrophied part returns to its sunken position, and the improvement of hearing at the same time passes away. It has to be observed, however, that a slight amount of atrophy is quite compatible with good hearing. The long-continued indrawn position of the membrane may also lead to permanent adhesions between it and the promontory or the articulation of the incus and stapes, or to permanent retraction of the tendon of the tensor tympani muscle. The retraction of this tendon is brought about by its being in a slackened condition for a length of time from the diminution of the distance between its point of attachment and the inner wall of the tympanum. This slackening induces in course of time a permanent shortening. In this state, when the membrane is forced out by inflation, slight improvement may take place, which is, however, very transient, as the membrane immediately returns to its previously sunken position.

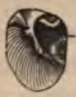

FIG. 75.

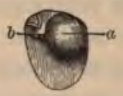

FIG. 76.

FIG. 75.—Left tympanic membrane in which there is atrophy of the postero-superior part—through the transparent, atrophied portion, above, is seen the articulation of the incus and stapes; below, the rounded border of the entrance to the fenestra rotunda. The atrophied membrane lies in close contact with these parts—*a*, centre of atrophied part of membrane.

FIG. 76.—The membrane immediately after inflation by Politzer's method, showing the bladder-like bulging of the atrophied portion—*a*, centre of atrophied part; *b*, short process of malleus.

2nd, In some persons the persistent hyperæmia leads in time to gradual thickening and condensation of the mucous membrane of the tympanum and Eustachian tube, while the exudation becomes gradually inspissated and organized, and adhesions, false bands, &c., form between various parts of the tympanum and between the walls of the Eustachian tube—changes which will be described under the heading of chronic dry catarrh. Why in some persons the interstitial exudation in the mucous membrane never changes from the cellular form, while in others it goes on to the new-formation of connective tissue, is not easily understood.

Diagnosis.—We recognise muco-serous catarrh of the middle ear chiefly by the appearance of the tympanic membrane and by the effects of inflation. If we are in doubt, puncture of the membrane with subsequent inflation will demonstrate the presence or absence of fluid exudation in the tympanic cavity.

Prognosis.—The prospects of complete recovery of the hearing are in most cases very favourable. The prognosis is less favourable—1. If there is a markedly hereditary tendency to chronic catarrh. 2. If the patient is of unsound constitution, especially if tubercular, scrofulous, or syphilitic. 3. If his position in life exposes him to the causes of ear catarrh, or if his habits are such as to be unfavourable to health. 4. If inflation of the middle ear, or incision of the membrane effects little or no improvement in the hearing. In this latter case we may suspect that, in addition to fluid exudation and swelling of the mucous membrane, there are also thickening and condensation, with other irremediable changes in the tympanic structures.

Treatment.—Our main objects should be—1st, to restore the proper tension of the tympanic membrane and ossicular chain; 2nd, to remove or promote the absorption of the exudation contained in the middle ear; and, 3rd, to remove the swelling and hyperæmia of the mucous membrane. Treatment of the nasal and pharyngeal mucous membrane and attention to the general health are important adjuncts to these.

Politzer's method of inflating the middle ear (see p. 24) is the most effective mode of attaining the *first* object, while it also assists materially in attaining the other two. Either Politzer's original method or Gruber's modification may be employed, as we find the one or the other to answer better. If the patient cannot come sufficiently frequently to the surgeon, the treatment by inflation, employing either the bag or simple tube, may be entrusted to the patient at home, with very careful and sufficient instructions. In order to overcome the resistance offered by plugs of mucus in the Eustachian tube or by the swelling of its walls, two or three compressions of the air-bag are frequently necessary before we are able effectually to inflate the tympanum. A loud crack is sometimes heard by the patient, when the inflation is successful. Immediately after, the patient usually feels marked relief—not only is there decided improvement in the hearing, but there is a sense of clearness in the head and relief to the fulness in the ear. The improvement in hearing is sometimes very striking, so that the patient, who previously could hear loud conversation only when spoken close to the ear, now hears the whispered voice several yards off, or the hearing distance of a watch may be increased from two inches to twenty or thirty inches.

The duration of the improvement of hearing is a guide to the frequency, with which we should employ inflation. If the improvement lasts for only a few hours, it should be performed daily for several days. As the duration of the improvement extends, the intervals may be increased to two, three, four days, &c., until, as shown by the normal hearing, the swelling has subsided, and the secretion become absorbed.

In the great majority of cases the use of the catheter is not called for, and indeed its employment is not desirable in this form of catarrh. There being frequently a state of acute catarrh of the nasal passages and pharynx, the contact of the catheter is apt to aggravate this, and thereby to increase the catarrhal condition of the ear. Besides, as a matter of experience, it is found that in this affection Politzer's method generally produces even a greater amount of improvement in the hearing than inflation by the catheter. In some rare cases the catheter may be necessary, but even in these cases one or two applications will suffice to prepare the tubes for effective inflation by Politzer's method. When the exudation in the middle ear is very thin and serous, a quantity of it may flow into the pharynx immediately after Politzer's douche has been applied, especially if during the inflation the patient's head is inclined forwards, downwards, and towards the opposite side.

In a large number of cases inflation of the middle ear, in conjunction with proper treatment of the nasal and pharyngeal mucous membrane, will suffice to bring about complete recovery of the organ. In a certain proportion of cases, however, in consequence of the secretion being too abundant or too viscid, it is necessary to make an *opening in the tympanic membrane* in order to ensure the complete removal of the exudation.

For a description of the details of the operation of paracentesis of the tympanic membrane see p. 116. We cannot better describe the indications for the operation in this affection than in the words of Politzer in his recent work.* He says, "I perform paracentesis of the tympanic membrane in those cases where, after the use of the other described methods of treatment for several days, no diminution of the exudation is observed, and where, even when exudation is not proved, the immediate improvement of hearing, which constantly follows the inflation of the tympanum, disappears in great part on the following day or on the second day thereafter. I also frequently perform the operation when, on the first examination, the collected mucus is found to be copious, for, although here a cure may be obtained through inflation alone, the treatment is protracted through several weeks, while by paracentesis a complete recovery is often effected in a few days. The great advantage of this operation, consequently, consists in the shortening of the time the patient requires to be under treatment."

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* "Lehrbuch der Ohrenheilkunde," von Dr. Adam Politzer. Stuttgart, 1878.

In a large number of cases a single operation will suffice. In all cases Politzer's method of inflating the middle ear must be employed at proper intervals after the operation. It may be necessary to continue the inflation for several weeks afterwards. After the mechanical irritation caused by the presence of the exudation has been removed, the secreting process usually stops. It is, on the other hand, occasionally necessary, if, after the wound heals, the exudative process still goes on, to make a fresh opening in a few days, and this may even in rare cases require to be repeated two or three times. Weber-Liel employs his *Paukenröhrchen* introduced through the Eustachian tube into the tympanum, in order to remove the secretion by suction (Fig. 35). This method, however, is more disagreeable and less effective than paracentesis.

In a certain proportion of cases the removal of the exudation and the use of Politzer's method, extending over a considerable time, do not bring about restoration or even much improvement of the hearing. This is due either— 1st, to a continued swollen or softened state of the mucous membrane of the Eustachian tube and tympanum, or, 2nd, to a permanent state of atrophy or flaccidity of the membrane from the long-continued increase of tension, or, 3rd, to thickening, condensation, and rigidity of the mucous membrane, especially of that covering the articulations of the ossicula or the fenestral structures.

The direct treatment of the mucous membrane of the Eustachian tube and tympanum for the reduction of the swelling is pretty much the same as that about to be described for chronic dry or adhesive catarrh. The best effects are obtained from the use of solutions or vapours alternated with inflation. Solutions are probably to be preferred, and the most suitable are those containing chloride of ammonium, bicarbonate of soda, or sulphate of zinc (f. 46 to 48). These should as far as possible be limited to the Eustachian tube by simply allowing them to flow into its mouth through a catheter or by employing the air-bag with gentle pressure. Good effects may be derived from the use of a solution of nitrate of silver (f. 44) in the manner described at p. 87. The treatment of atrophy, retraction of the tendon of the tensor tympani muscle, and the other consequences of mucous catarrh will fall to be considered under the treatment of chronic dry catarrh of the middle ear.

The swollen and softened state of the mucous membrane is frequently associated with catarrhal swelling of the nasal and pharyngeal mucous membrane, and in many cases with adenoid vegetations. These must be effectively treated in order to secure permanent recovery of the middle ear (see chapter on diseases of the nose and throat in Part First).

General remedies should be employed if the patient is strumous, anæmic, or syphilitic (f. 91 to 107). For the hygienic treatment the student is referred to p. 147.

III. Chronic Dry or Adhesive Catarrh of the Middle Ear.

Syn.—Adhesive Processes in the Middle Ear (*Politzer*)*; Proliferous Inflammation of the Middle Ear* (*Roosa*)*; Chronic Catarrh of Middle Ear.*

The pathological conditions included under this designation constitute a large proportion of cases of deafness. In frequency this disease comes next to chronic suppurative inflammation of the middle ear. Out of 1088 cases of ear diseases, recorded by the writer, 291 or about 27 per cent. were classified under this heading.

Pathology.—There are two pretty well marked groups of cases—1st, Those in which the symptoms point to a distinctly catarrhal process; 2nd, Those in which there is absence of markedly catarrhal symptoms—the term *sclerosis* of the middle ear being sometimes applied here. In the *first* group the pathological changes found in the middle ear frequently arise out of mucous catarrh or non-perforative inflammation. After simple hyperæmic swelling the mucous membrane becomes, owing to new formation of connective tissue in its interstices, thickened, and in many cases the seat of chalky or fatty deposition. The thickened and condensed mucous membrane usually in course of time undergoes a shrinking process. The secretion may also become inspissated and organized, agglutinating the ossicula, and hindering their movement. Adhesions, connecting bands, and pseudo-membranes form, so that parts, which are usually separate, come to be in contact, and after a time unite. In this way the tympanic membrane may form adhesions with the inner wall of the tympanum or with the ncus or stapes; or the crura of the stapes may become firmly adherent to the walls of its recess. The ligaments connecting the ossicles with the walls of the tympanum may, on account of the change in the mucous membrane covering them, become contracted and rigid, and in this way these small bones may be bound down and fixed. The tendons of the tensor tympani and stapedius muscles may also be contracted from the same causes. Further, there are frequently found bands or filaments of connective tissue, connecting and binding various parts of the tympanic walls and contents—thus, the tympanic membrane may be connected with the inner wall of the tympanum, the ossicles with the inner walls of the tympanum or with one another. The cartilages and capsules of the joints between the ossicles become in many cases stiffened, rigid, and adherent. The malleo-incudal joint and the connection between the edge of the footpiece of the stirrup-bone and the annular ligament are especially apt to share in this stiffening process, and in the case of the latter osseous union not unfrequently takes place. Exostosis and hyperostosis of the osseous tympanic walls or of the ossicula are also sometimes found.

We may have in these various ways, 1. the free space of the tympanum much diminished or even obliterated; 2. the tympanic cavity divided into compartments completely separated from each other by adhesions or connecting bands; 3. the whole chain of bones or individual bones fixed or bound to the walls of the tympanum, or firmly anchylosed to one another, or stiffened by the thickened mucous membrane covering them; 4. the stapes adhering or bound to the walls of its recess, or united immovably to the edge of the fenestra ovalis; 5. the membrane closing the fenestra rotunda and the annular band of the fenestra ovalis thickened, stiffened, or perhaps ossified or calcified; 6. the tympanic membrane thickened to several times its normal state. *As the result of these pathological changes the conduction of* *sound through the tympanum to the labyrinth is more or less seriously impeded.*

The whole extent of the mucous membrane lining the walls and contents of the tympanum may be involved, or the morbid process may be limited to one part. The function of the tympanum is most seriously injured, when the ossicular chain, the annular ligament of the fenestra ovalis, or the membrane of the fenestra rotunda is the seat of the pathological changes.

In many cases the ventilating function of the Eustachian tube is impaired by thickenings in its mucous membrane, or by adhesions or connecting bands, which prevent due separation of the walls of the tube during the act of swallowing, &c. Or the defective opening of the tube may be caused by imperfect action of the two tube muscles—the abductor tubæ and the levator palati—which may have undergone fatty degeneration, or become atrophied or paralysed. In either case the defective ventilation of the tympanum leads to the indrawn tympanic membrane with its consequences (see pp. 285 and 289).

In the *second* group, or sclerotic form of chronic catarrh, adhesions, false bands, indrawn membrane, and inspissated secretion are not frequently found. The changes are more those of thickening, condensation, and loss of elasticity of the mucous membrane, which are frequently *limited to the fenestral structures and recesses*—calcification of the membrane of the fenestra rotunda and annular ligament of the fenestra ovalis—anchylosis of the ossicula, especially of the footpiece of the stapes, and exostosis or hyperostosis of the osseous walls of the tympanum or of the ossicula. The Eustachian tube, in this form, is frequently more permeable than in the normal state.

While disease of the labyrinth may become associated with any of these pathological conditions, it is found to be a much more frequent attendant upon the second than upon the more purely catarrhal form.

The condition of the mastoid cells is not very well understood; but these spaces are said to be frequently encroached upon by thickening of their lining membrane or of their osseous walls.

Causes.—While we found that muco-serous catarrh is met with most frequently in youth or childhood, chronic dry catarrh is common in adult age. It is often found in persons or families otherwise perfectly healthy. In childhood, however, the existence of a scrofulous diathesis seems to favour the development of muco-serous catarrh into chronic dry catarrh. Hereditary influence undoubtedly plays an important part in the causation of this disease.

As already stated, the more distinctly catarrhal forms of the disease may originate in acute non-suppurative inflammation or in muco-serous catarrh, particularly after repeated attacks of these affections. No doubt neglect of treatment is sometimes responsible for this. Just as we found in the other inflammatory diseases of the middle ear, the *fons et origo* of the mischief is often in the nasal and pharyngeal mucous membrane. In a large number of cases it will be found that the person is liable to "cold in the head," and that he attributes the beginning of the disease to this cause. In persons predisposed to the disease injudicious cold-water bathing is apt to induce it.

Syphilis may give rise to this affection, and, in this case, its course is usually very rapid, very marked and hopeless deafness, with labyrinthine complication, frequently resulting.

Paresis, atrophy, and fatty degeneration of the muscles of the Eustachian tube and soft palate are probably not unfrequent causes of the disease. Diphtheria, anæmia, tuberculosis, or indeed any debilitated state of the constitution may impair the functional activity of these muscles. The student is referred to the section on the etiology of ear diseases for further details of the causation of chronic dry catarrh of the middle ear.

Subjective Symptoms.—The symptoms complained of most frequently are *defect of hearing* and *subjective sounds in the ear.* The extent of deafness varies very much in different cases and at different stages of the same case. This is chiefly due to variation in the seat of the pathological changes, the deafness being very marked in fixation of the stapes along with thickening and rigidity of the membrane of the fenestra rotunda. While, if the labyrinth also becomes diseased, the deafness may be almost complete. The defect of hearing is frequently very insidious in its origin, as well as slow and gradual in its progress. If the morbid changes be confined to one ear, the patient may, for a considerable time, be quite unconscious of any impairment of hearing, and the disease may exist for a long time even in both ears without materially disturbing him either in his social or business relationships; besides, the patient is unwilling to admit the existence of defective hearing at all, even after it has become very apparent to his friends. Hence in our inquiries it is often very difficult or impossible to ascertain the exact commencement of the dulness of hearing.

The degree of deafness, especially in the catarrhal forms, is liable to fluctuation, although not in so marked a way as in mucous catarrh. It is usually aggravated for the time by cold, moist, and dull states of the atmosphere, which influence injuriously the mucous membrane of the Eustachian tube; but extreme heat may also act unfavourably. It is to be remembered that, when the mucous membrane of the Eustachian tube is in a state of permanent swelling or thickening, a very slight additional swelling, say from a "cold in the head," will have a more important effect on the hearing than in the case of a previously normal Eustachian tube. In these conditions crackling sounds, occasionally followed by transient improvement of the hearing, are sometimes heard by the patient. The deafness is also often aggravated by bodily and mental fatigue, by indisposition, by strong emotion, by much speaking, during eating, by alcoholic stimulants, by excessive smoking, by the use of quinine or salicine, and by hot close apartments. In these cases the aggravation is due either to a change in the condition of the Eustachian tube, or to a change in the perceptive power of the auditory nerve. If the deafness does not fluctuate but remains the same or slowly progresses in severity, the pathological changes probably belong to the second group.

The phenomenon of *paracusis Willisii*, or hearing better in a noise, is not unfrequently observed (see p. 43). A want of proportion between the power of hearing simple tones, such as the tick of a watch, and speech is also found occasionally to exist (see p. 41). Politzer believes that, when a tone, such as the tick of a watch, is heard better in proportion than speech, there is rigidity of the ossicular chain, while the membrane of the fenestra rotunda is normal, the sound waves in such a case reaching the labyrinth through the latter channel. Musical tones are usually heard quite distinctly, unless where the deafness is extreme. A somewhat remarkable phenomenon is sometimes observed, both in the earlier and in the later stages of the disease, namely, painful impressions produced by sounds, the so-called *hyperæsthesia acoustica*. On account of this peculiarity such patients cannot tolerate loud speaking or the use of a hearing trumpet.

The perception of sound by *osseous conduction* is usually increased. In cases, however, which have been obstinate and long continued, and especially when attended by great noises in the ear, the osseous perception may be much diminished. This is also found when the disease is complicated with syphilis, although not of long duration.

Next to defective hearing the most important and common symptom complained of by the patient is some form and degree of subjective sounds in the ear—*tinnitus aurium* (see p. 467). A very large number of persons, who have this disease, suffer from this symptom. The subjective sounds are sometimes complained of before any deafness is experienced, especially in gradual anchylosis of the stapes; at other times the deafness and the noises in the ear come on simultaneously, while in many cases the "tinnitus" comes on some time after the impairment of hearing has been noticed. The descriptions given by patients of the character of these sounds are very varied. They may be likened to the humming of a shell, the buzzing of bees, steam escaping from a pipe, the sound of a waterfall, the singing of a kettle, water falling into the fire, &c. (see p. 468). In many cases these sounds are much more annoying than the deafness, the patient asserting in earnest tones that he could get on in spite of the deafness, but that the noises in the ear are most distracting, and a terrible affliction. They often become more aggravated as the deafness increases, until the patient may come to the sad position of being shut out from all external sounds, while he is tormented with intolerable noises within the head. At other times, when the insensibility to external sounds has become almost complete, the subjective noises in the ear fortunately disappear, probably owing to complete paralysis of the nerve of hearing. They are generally worse in the evening, and in the house as compared with the free, open air; while in a quiet room they are heard much more loudly than amid the noise and engrossments of business, when for the time they may not be perceived at all. The causes, which have been mentioned as increasing the deafness (see p. 300), usually also aggravate the tinnitus aurium.

While *pain* is seldom complained of, a sense of fulness, pressure, or "stopping up" in the ear is not unfrequently spoken of by patients. It is sometimes difficult to convince a patient that there is not an actual obstruction in the canal of the ear, which would be easily removed. When actual pain is experienced, it is generally due to dental irritation or to neuralgia of the tympanic plexus.

Some patients suffer from a sense of pressure in the head, and others from dull pain over the frontal sinus. Localized pain in the head, which is usually regarded as neuralgia, is also occasionally complained of. This is probably of a reflex character, due to the irritation of the mucous lining of the middle ear transmitted, chiefly through the branches of the trigeminus, to the nerves of the head, just as we find in pain due to dental irritation.

Giddiness, either temporary or permanent, sometimes along with sickness and vomiting—symptoms often attributed to disease of the brain or nervous system—is not unfrequently met with. In these cases the deafness and noises in the head have usually been very marked. This group of symptoms, namely, deafness, noises in the head, giddiness or unsteadiness of gait, and sickness or vomiting, is generally termed Ménière's disease. While these symptoms, when arising suddenly, are probably due to a pathological change in the semicircular canals (see p. 455), they may also undoubtedly be excited by pressure upon the labyrinthine fluid from the direction of the tympanum.

Mental and *nervous* disturbance, such as diminished power of mental work and depression of spirits, seems occasionally to be connected with these chronic processes in the ear. Patients assert that an amount of mental work, which they could at one time perform with ease, has now become impossible. These symptoms, indicative of disturbance of the peripheral and central parts of the nervous system, probably occur in persons, whose nerve force or resisting power is either naturally weak, or has been impaired by causes acting on the system independently of the ear disease. Probably also the distracting influences of the noises in the ear may have something to do with the restlessness and inability to engage in mental work. It is to be noted that these nervous phenomena, in connection with chronic catarrh of the middle ear, are met with not only in nervous females but also in men of strong will.

Objective Symptoms.—Before describing the changes found in the tympanic membrane, it must be observed that we cannot, in any case, determine the extent of the deafness from the appearance of the membrane. While in some cases of extreme deafness, due to this affection, the membrane is almost normal in appearance, there are others in which the hearing is only slightly impaired, although the membrane presents great abnormality. In the former case probably the fenestral structures are the seat of the pathological changes, while in the latter the morbid changes are limited to the tympanic membrane. The condition of the membrane is nevertheless to be carefully studied, as its appearance not unfrequently throws light upon the diagnosis and prognosis.

A change in the position of the membrane similar to the "indrawn" or "sunken" condition described at page 285 is very frequently observed (Fig. 77). While in mucous catarrh inflation is usually sufficient to force out the membrane, and restore it to its natural position, we find that, in chronic catarrh, it becomes in most cases so fixed and immovable, owing to organized adhesions between it and the inner wall of the tympanum or between it and the incus or stapes, that neither inflation nor suction with Siegle's apparatus is capable of restoring the proper curvature. Atrophied parts and localized or limited indrawings of the membrane, due to adhesions or bands, are also met with. In front of the upper part of the manubrium, for example, the membrane is in many cases distinctly sunken, imparting an unusual sharpness and depth to this part of the manubrium. Behind the upper part of the manubrium depressions are frequently seen, the depressed portion of the membrane probably adhering to the long process of the incus and the head and posterior crus of the stapes. Pittings of the membrana flaccida are also not unfrequent. A depression, sometimes of considerable size, behind and below the umbo is occasionally present, and is due to adhesion of a portion of membrane to the promontory.

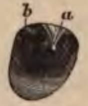

FIG. 77.—Indrawn tympanic membrane caused by obstruction of the Eustachian tube. *a*, short process of malleus with the indrawn manubrium below; *b*, part of stapes connected with long process of incus—both seen through the membrane lying closely over them.

The outer surface of the tympanic membrane frequently retains its normal lustre, owing to the epidermic layer being in many cases unaffected, and hence the manubrium is generally seen distinctly through the transparent dermoid layer. If, however, the dermoid layer is thickened and dull, both the general polish as well as the cone of light may be altogether absent, and the manubrium may either be very indistinctly seen, or quite invisible. The cone of light is affected by change in the curvature of the membrane, especially in the indrawn membrane. It may in that case become divided into several parts, or extremely narrow or irregular at its edges, or it may be reduced to a point. Some writers attach an undue importance to these changes in the cone of light.

The colour of the membrane is frequently found changed either in its whole extent or at circumscribed parts. Instead of a general pearly grey colour it is often a whitish grey or almost quite white like opal glass. More rarely it has a general leaden grey, or yellowish grey tint. Local changes of colour are still more frequently observed. A whitish ring, of variable breadth, is pretty often seen round the periphery of the membrane (Fig. 78). This is looked upon by some as analogous with the *arcus senilis* in the eye, but it is also met with in young persons. Behind the upper part of the manubrium a whitish stripe, extending backwards, is sometimes seen, which is probably due to adhesion of the leaf of the posterior pouch of the membrane to the membrane itself. White thickened bands may also be found extending from the umbo to the lower part of the periphery of the membrane. When the mucous membrane lining the inner wall of the tympanum is hyperæmic and the membrane lies close to it, the membrane presents, especially in its lower half, a reddish tinge.

But the most frequent form of greyish white opacity is found in the posterior half of the membrane. This opacity has usually a semilunar shape, with the concavity forwards, but having an irregular edge. In the same position, and frequently of the same shape, but sharply demarcated from the neighbouring parts of the membrane, there is not unfrequently a very well-marked white or yellowish white appearance. It is due to a calcareous deposition in the layers of the membrane (Fig. 79). A similar deposition but more oval in shape is less frequently seen in front of the manubrium. This sometimes unites below with a deposition behind, when a calcareous patch is formed having a horse-shoe shape (Fig. 80). Calcareous deposition in the tympanic membrane is most frequently met with in connection with chronic purulent disease of the middle ear (see p. 348), although it is not rare in the affection we are now considering.

There is usually thickening of the membrane in addition to whiteness or opacity. This is generally in the inner or mucous layer, which may become three or four times thicker than normal. But, instead of being thickened, the membrane is sometimes found to be thinned or atrophied owing to the prolonged tension from long existing impermeability of the Eustachian tube (see p. 289). Sometimes a part of the membrane is atrophied, while the rest may be thickened.

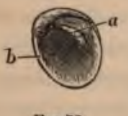

FIG 78.

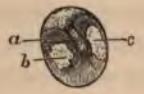

FIG. 79.

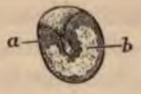

FIG. 80.

FIG. 78.—Left tympanic membrane very much "sunken," and showing the white ring at the periphery—*a*, middle of manubrium, which is very much drawn in; *b*, white ring.

FIG. 79.—Left tympanic membrane, having patches of calcareous deposition—*a*, middle of manubrium; *b*, calcareous deposit in front of manubrium; *c*, deposit behind manubrium.

FIG. 80.—Left tympanic membrane, showing calcareous patch having a horseshoe shape—*a*, manubrium; *b*, calcareous patch.

As has been already mentioned, the membrane is much less altered in the sclerotic form than in the more strictly catarrhal form. In the former there is frequently no change in the curvature of the membrane. The lustre or colour may likewise be but little altered—sometimes a slight increase of greyness is seen at the peripheral parts or a yellowish grey in the posterior part. The manubrium and short process may appear smaller; the manubrium being at the same time thinner, sharper, and whiter. Its edge has at times also a nodulated appearance. The membrana flaccida is in many cases much smaller than in the normal state.

Auscultation during inflation through the catheter or by

Politzer's method generally gives evidence of obstruction of the Eustachian tube (see p. 22). But it is to be noted that the auscultation sound may be full, clear, and blowing, indicating a wide tube, although great deafness may exist from chronic processes in the tympanum. In such cases either the earlier thickening of the mucous membrane of the tube has given place to atrophy with abnormal width of the canal, especially at the isthmus, or the catarrhal process has been from the beginning pretty much confined to the tympanum, the Eustachian tube having been but little affected. Patients are not unfrequently met with, in whom there is on the one side extreme and long-standing deafness with great permeability of the tube, while on the other there is more recent deafness with the signs of obstruction of the Eustachian tube. It will usually be found that the ear with the obstructed Eustachian tube is much more amenable to treatment than the other.

Course.—In the great majority of cases the pathological changes in the middle ear advance, often slowly and gradually, with increase in the deafness and tinnitus. The adhesions become stronger, the thickening and contraction of the mucous membrane increase, calcification and ossification may develope, and ultimately, in many cases, the labyrinth shares in the morbid process. The defect of hearing sometimes remains stationary for many years, and then becomes gradually or rapidly worse. If the labyrinth remains intact the deafness can never be total, although the pathological processes in the middle ear may be so far advanced as to result in complete fixing of the stapes. After the hearing of one ear has become very seriously impaired, the other ear usually begins to be affected, and it is not unfrequently found that the second ear, before long, becomes more seriously involved than the first, the patient remarking that the ear, which was first affected, and the hearing of which he supposed to have been totally gone, is now the only one with which he hears anything at all. Much less frequently the disease pursues a rapid course, the hearing becoming rapidly and seriously damaged in a few months, probably without much alteration in the condition of the tympanic membrane and Eustachian tube. Here the process probably begins in the fenestral structures, and then extends inwards to the interior of the labyrinth. In a syphilitic patient the course of the disease is usually very unfavourable, the deafness and noises in the head becoming rapidly worse. Sudden and loud noises, such as the report of a gun unexpectedly in the neighbourhood, and injuries to the head, are not unfrequently followed by marked aggravation in the symptoms. Spontaneous and permanent improvement is very rare. The condition is, on the other hand, often more or less aggravated by an attack of sero-mucous catarrh, acute non-suppurative inflammation, or acute suppurative inflammation of the middle ear. After these complications have passed away the hearing power may return to its previous condition, but it is more frequently left rather worse than before. Some rare cases are reported of actual improvement to the hearing resulting from an acute purulent process. The ceruminous secretion is not unfrequently excessive in quantity and abnormally dry (see p. 176). In other cases, especially in the sclerotic form, there is deficiency of this secretion.

Patients suffering from chronic catarrh in one ear have frequently some other affection in the opposite ear. This may be chronic suppurative inflammation, impacted cerumen, mucous catarrh, or acute suppurative inflammation.

Diagnosis.—The diagnosis of chronic catarrh is generally easy, and is based upon the examination of the tympanic membrane and the Eustachian tube, as well as upon the subjective symptoms and the history. The most important point in the diagnosis is to distinguish disease in the labyrinth or auditory nerve from disease in the conducting structures, especially when the tympanic membrane and the Eustachian tube are found to be normal. This is considered fully in the section on the examination of the auditory nerve, p. 31, and also at p. 460, where the subject of labyrinthine disease is discussed.

The existence of adhesions, atrophy, or increased tension of the tympanic membrane and ossicular chain is usually made out by means of Siegle's speculum, or by inflation of the middle ear. The immobility of an adherent portion of membrane and the great mobility of an atrophied portion (see p. 290), during the alternate condensation and rarefaction of the air in the external auditory canal, usually point out pretty clearly the presence of these conditions. If there is excessive mobility of the membrane, there is defective tension of the membrane; on the other hand, if the mobility is very slight, there is probably undue tension.

Stiffening, rigidity, or anchylosis of the ossicles cannot always be ascertained with certainty. Complete absence of movement of the manubrium during the use of Siegle's speculum or during inflation is presumptive evidence either of rigidity of the whole chain or of the malleo-incudal joint. If speech is not heard through a hearing-tube inserted into the external auditory canal, while it is heard when very loud if spoken close to the head without a hearing-tube, we may assume anchylosis of the ossicula. When words, spoken into a hearing-tube, connected to the outer end of a catheter introduced into the Eustachian tube, are heard, the presumption is that the stapes is movable, while the malleus and incus are rigid. Further, when the labyrinth is proved to be intact, and yet no improvement whatever follows repeated inflation, there is probably a stiff immovable condition of the whole or some part of the ossicular chain.

Prognosis.—The question as to what shall be the likely course of this disease in any particular case is fraught with intense interest and importance to the patient. In estimating this, it is to be remembered that a chronic catarrh of any mucous membrane is a very intractable if not incurable condition. Even after improvement has been attained by treatment, it is well known that relapses are extremely apt to result from climatic causes, &c. Chronic bronchitis is an illustration of the real incurability of a catarrhal condition after organic changes have taken place in the mucous membrane.

Here in the middle ear there is a rooted catarrh of a mucous tract in intimate connection with a mucous membrane, namely, that of the nose and throat, which is exposed more than any other to injurious atmospheric or climatic influences. Again, when it is considered that this small region, enclosed in great part by unyielding bones, is occupied by structures, the delicacy of whose vibrating power is of paramount importance to the due performance of the function of hearing, and that the processes in chronic catarrh lead to stiffening, rigidity, and immobility of these parts, it is impossible to escape the conviction that after a time complete structural and functional restoration is impossible. This lapse of time has, unfortunately, usually taken place before treatment is asked for or resorted to. The painless course of the disease and the at first almost imperceptible and extremely gradual loss of hearing explain why the patient rarely comes for advice, until the pathological processes have gone on for one year, five years, or even ten years. It is then frequently found that the hearing of one ear is extremely defective, while that of the other ear is gradually failing. There can be little doubt that, if patients and physicians knew the ordinary course of the disease, earlier treatment would be sought for, with, in many cases, most beneficial effects.

The surgeon is therefore unfortunately always compelled to explain to the patient that complete restoration of the hearing is not possible. We are thus limited to the consideration of the question, Shall the hearing become gradually worse, or shall it remain as it is, or may it improve? It must be admitted that it is not always possible to decide, from the history and symptoms of a given case, which of these three courses will be taken by the disease. It is often necessary, before deciding, to apply the additional test of treatment.

In the first place, it may be said that the more clearly the pathological processes are catarrhal in their nature and origin, and the more clearly they are connected with morbid states of the naso-pharynx, the better are the prospects of improvement. In these circumstances it may be reasonably expected that by repeated inflation the adhesive and contracting processes may be checked through the mechanical action of the air douche, and, by proper injections through the Eustachian catheter, the thickened mucous membrane may be stimulated so as to lead to partial absorption of the interstitial exudation. If, in addition, the naso-pharynx, as well as the general constitutional condition, receives judicious treatment, we may expect in many cases to improve the hearing, or at any rate to maintain it as it is.

We may regard the prospects as favourable, 1. If inflation of the middle ear is immediately attended by appreciable improvement in the hearing or by relief to the *tinnitus*. This may indicate that a fresher process has recently come on, with perhaps some swelling of the mucous membrane or some free exudation, and the treatment, by removing these, may markedly improve the hearing. Or in such a case the improvement may be due to the adhesions not being so far organized as to prevent the partial restoration of the proper tension of the membrane and ossicular chain. 2. If the perception by osseous conduction of sound is unimpaired and the defect of hearing is not extreme, although of long continuance, the likelihood is that at least no increase of the deafness will ensue. 3. If there is and has been complete absence of, or only slight and occasional, subjective sounds in the ear. 4. If there is no distinct hereditary tendency to the disease, and no cachectic condition exists, such as scrofula, tuberculosis, or syphilis. In these cases we may reasonably expect improvement, or at least that the present hearing shall be retained.

If, on the other hand, effective inflation of the middle ear is not attended by the slightest improvement in the hearing or in the *tinnitus*, if the deafness is very marked and associated with great noises in the ear, if the symptoms are of many years' duration, beginning imperceptibly and advancing slowly but surely, and especially if the osseous conduction of sound has become impaired, while, in addition, the tympanic membrane is but little changed from the normal, if the Eustachian tube is freely permeable, and no catarrhal signs exist in the naso-pharyngeal mucous membrane, the prognosis is very unfavourable. Probably the case belongs to the sclerotic group, and the structures essential for the conduction of sound, especially the stapes, are hopelessly rigid, while probably also secondary changes have resulted in the labyrinth itself. If the surgeon is able to relieve the noises in the ear and to preserve what remains of the hearing power, he may consider himself fortunate. When the disease has been of short duration, while the deafness is extremely marked, with great tinnitus and no sign of exudation in the middle ear, and especially if defective osseous conduction has ensued, the prospects are unfavourable, and it is probably a middle ear disease with a concomitant affection of the labyrinth.

Old age is an unfavourable element in the prospects of a case. So are bad hygienic conditions, improper living, and unhealthy occupations. Scrofula, tuberculosis, and especially syphilis have very unfavourable influences upon the course of the affection. Disease of the middle ear in connection with the syphilitic constitution rarely confines itself to that part of the ear, but generally produces also a change in the labyrinth. Distinct hereditary tendency must also be looked upon as an unfavourable feature in any case.

As has been already said, however, the test of treatment for a time is often necessary before a final or categorical opinion can be given. We can never know in a given case to what extent the more purely catarrhal and the sclerotic conditions commingle, until we have observed the effects of treatment.

Treatment.—The treatment may be divided into three parts:—1st, the local treatment of the ear; 2nd, the treatment of the nasal and pharyngeal mucous membrane; and 3rd, the general constitutional treatment.

The Local Treatment of the Ear.—This aims at, 1st, restoring the proper tension of the tympanic membrane and ossicular chain; 2nd, counteracting the adhesive, thickening and contracting processes, which are going on in the middle ear.

The most important means of attaining these objects is inflation of the middle ear either with the catheter, by Politzer's method, or by both combined. For the explanation of the therapeutic value of inflation of the middle ear and the comparative merits of catheterization and Politzerization, the reader is referred to the chapter on Methods of

Treatment, page 99. The best results are attained in most cases by the combined use of the catheter and of Politzer's method. When the Eustachian tube is considerably obstructed, and the tympanic membrane markedly sunken and thickened, the use of the catheter, at intervals of three days for from four to six weeks, is required. If there is great resistance to the entrance of air into the cavity of the tympanum, as shown by the character of the auscultation sound and by the fixed position of the membrane, five or six strong compressions of the air-bag at each sitting are essential. On the other hand, if the tube is freely permeable, or the membrane is atrophied, the compression should be very moderate. After catheterization has been carried on for that period of time, it is usually desirable to continue inflation by Politzer's method for a month longer. This method should be employed every second day, and in many cases the patient will be quite able, after proper instructions, to carry it out at home. Sometimes Politzer's method is more effective in improving the hearing and relieving the subjective noises than the use of the catheter, though the reverse is more frequently found to be the case. By either method, the therapeutic effects are never so striking nor so lasting as in muco-serous catarrh. A temporary slight aggravation may even be caused by inflation, which, however, soon passes off, especially after swallowing. The best effects are obtained when the mucous membrane has still a certain degree of softness and flexibility, and when the tympanic membrane is not fixed immovably in an abnormal position, or the ossicula have not become completely rigid. The improvement in the hearing or in the noises in the ear, which may follow inflation, is at first transient ; in atrophy of the membrane or retraction of the tendon of the tensor tympani the duration of the improvement may not exceed a few minutes. The parts stretched out by the mechanical effects of the inflation soon shrink or fall back again. When improvement of hearing lasting one or two days follows each of the first few inflations, the ultimate result of treatment is likely to be much more favourable, than in cases where no improvement whatever follows the first few inflations.

The therapeutic effects of inflation of the middle ear are often augmented or assisted by the application to the middle ear of medicated *solutions* or *vapours* or by the use of bougies or tents, simple or medicated.

For the description of the method of introducing solutions and vapours into the middle ear through the Eustachian catheter, and their value, see chapter on Methods of Treatment, page 112. In the use both of solutions and of vapours it is well to employ them alternately with inflation by Politzer's method or by catheterization at intervals of two or three days for several weeks.

When great swelling of the lining membrane of the Eustachian tube, or almost complete stricture by adhesions, exists, neither inflation nor the introduction of vapours or solutions may be possible. In these cases cautious attempts may be made (only by the experienced aural surgeon) to reduce the great swelling of the mucous membrane with strongly stimulating substances, or to dilate the canal by mechanical means. When the mucous membrane is simply swollen it is recommended by Politzer to introduce through the catheter, as far as the isthmus tubæ, for a few seconds, a violin string, the end of which, to the extent of two inches, has been previously dipped in a saturated solution of nitrate of silver or sulphate of copper, and then allowed to dry. It is asserted that, if this is employed every third day for three or four times, the swelling of the mucous membrane of the Eustachian tube may be reduced to such an extent as to allow of effective inflation by Politzer's method. When this fails in opening the canal sufficiently to allow of a stream of air passing into the tympanic cavity, the experienced surgeon is justified in attempting gradual mechanical dilatation by means of thin gum bougies, which may be coated with some medicament likely to act beneficially on the mucous membrane. Laminaria and sponge tents are recommended by some surgeons for dilating a constricted Eustachian tube; but this is a method of treatment which even the experienced aural surgeon is hardly justified in attempting. On the whole, efforts to dilate the Eustachian tube by mechanical means are attended by very limited success. Frequently, owing to the character of the stricture, it is quite impossible to dilate it; while even in cases where complete dilatation has been achieved no improvement has taken place in the hearing or in the subjective sounds in the ears. Only in a few is even successful dilatation attended by permanent benefit.

In cases associated with great noises in the ear rarefaction of the air in the external auditory canal is sometimes of service. The conditions in which this method of treatment does most good are those associated with great retraction of the membrane from adhesions, &c. A more beneficial influence is secured by employing inflation of the middle ear before the process of suction. In cases where the symptoms are very severe, where great deafness and most disturbing noises in the head exist, Woakes's method (see p. 121), which is capable of exerting great traction upon the membrane even to the extent of tearing it when bound down by adhesions, may be cautiously tried. Where gentler suction relieves, the patient may, as in inflation, employ it at home with the air-bag and proper ear-piece. The more gradual method of suction (see p. 121) is said by Politzer to afford more enduring though less rapid improvement.

It has to be confessed, however, that this method of treatment is often quite ineffectual in relieving the patient. In some there is improvement in the hearing and relief to the sounds in the ear; this improvement is, unfortunately, in most cases but temporary, lasting merely for a short time after the suction process.

Dr. M'Keown, of Belfast,* advocates the application of collodion to the outer surface of the tympanic membrane when the membrane is flaccid, or where adhesions exist between it and other parts. He claims for collodion applied in this way that, by firming and exercising traction upon the membrane, it tends to prevent or destroy adhesions, and replace the membrane in its normal position.

Electricity is sometimes employed, mainly in the form of the induced current. Its mode of application and its value as a remedy are discussed in the chapter on the Methods of Treatment at page 122, to which the reader is referred.

We have still to mention incision of the tympanic membrane—*Myringodectomy*—as a mode of treating certain forms of this affection (see page 116). There are two conditions in which incision of the membrane may be useful. The *first* is that of an extremely retracted membrane with great prominence of the posterior fold and short process. In such a condition, if the hearing is very defective, and the subjective sounds very distressing, a perpendicular section through the middle of the posterior fold is not unfrequently attended by benefit, especially as regards the sounds in the ear. The good effects of such an incision depend on the partial setting free of the manubrium and its assuming a more normal position. Of course, no effect can be hoped for, when the fenestral structures are rigid, or the ossicular chain anchylosed. It has to be added that, while the relief is sometimes permanent, it is unfortunately more frequently only temporary. The *second* condition in which incision of the membrane may be beneficial is in the case of the atrophied or flaccid membrane. Three or four incisions are made in the atrophied part. They heal usually in twenty-four hours, and should be repeated every fourth day for two weeks. The beneficial effects are due to the contraction of the linear cicatrices and the consequent firming up of the flaccid tissue. In some cases these multiple incisions are followed by a very good and permanent effect; at other times the good effect is only temporary, while in some there is no improvement at all. The treatment is, however, almost quite free from any risk of inflammatory complication.

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* See *British Medical Journal*, 20th December, 1879.

Attempts to maintain a *permanent opening* in the tympanic membrane have hitherto failed. These attempts have taken the form of excision of a portion of the membrane, of introducing an eyelet into the opening (Politzer), of removal of a part of the manubrium and the severing of the vessels which supply the membrane, of cauterizing the edges of the opening, or of applying concentrated sulphuric acid; and they have all equally failed. In the course of time, usually in not more than two or three months, cicatricial tissue forms, and the artificial perforation is closed. The most recent effort, introduced by Voltolini, consists in burning a hole in the membrane with the galvanic cautery. The point of the burner (see p. 126) is applied with very slight pressure to the postero- or antero-inferior quadrant. This method, though perhaps the best yet tried, has not brought us to the desired goal. It is found that the opening made in this way also heals in course of time. If it were possible to maintain a permanent opening, a certain number of cases of deafness would undoubtedly be improved. When the tympanic membrane is so thickened or changed, that the sound-waves cannot properly pass through it, or where the Eustachian tube is completely occluded, while the fenestral structures are freely movable and the labyrinth intact, an opening in the membrane is likely to improve the hearing, and probably relieve the *tinnitus.* And it is found by experience in these cases that, so long as the opening remains, the improvement continues; but, as soon as it is closed by a cicatrix, the improvement disappears.

We have lastly to refer to *division of the tendon of the tensor tympani muscle* as a method of treatment. If it were possible to ascertain with certainty in any case that the deafness and subjective noises depended solely or even mainly upon retraction of this muscle, division of its tendon would be a justifiable, and even a reasonable proceeding. But we are not able to do so, and it is well known that in nearly all cases of retraction of this tendon, adhesions, thickenings, and contractions of various kinds exist at the same time in the cavity of the tympanum. As might be expected, therefore, good results from this operation are either temporary or altogether absent. It is also to be remembered that there is a possibility, as experience has shown, of damaging the hearing still further by this operation. If attempted at all, it should only be done where the deafness is already of an extreme character, and where the *tinnitus* is such as to demand every effort to relieve it. Politzer says that "it is one of those operations, which not only are of but trifling use, but which sometimes also have a deleterious influence upon the function of hearing."

In concluding this review of the local treatment of the various pathological conditions found in chronic dry catarrh, it may be stated, as the experience of aural surgeons, that in most cases all the benefit to be derived from local treatment of the ear is secured by inflation of air. In a certain number of cases, however, a greater effect is achieved by alternating the air-inflation with the injection of fluids or the introduction of vapours. An important question to decide is, how long should treatment be continued. It may be said that, if no improvement results either in the hearing or in the tinnitus after a month's treatment, carried out on the lines which have been laid down, the surgeon is justified in abandoning local aural treatment as likely to be useless. If, on the other hand, appreciable improvement takes place at an early stage, so long as this improvement gradually progresses the treatment should be continued. When no further improvement is observed, the surgeon must be careful not to prolong the treatment over too great a space of time, otherwise the advantage gained may be completely lost. The maximum of good is usually attained in less than six weeks. After this a pause should be made of two or three months, and then inflation should be again practised either with the catheter or by Politzer's method, according as either of these answers best. If Politzer's method serves the purpose, the patient may go on with it at home every second day for six weeks. After this the surgeon must be guided as to the propriety of further local treatment by the state of the patient. In many cases it is found that, in order to maintain the improvement, or to prevent relapse, the local treatment requires to be repeated at least twice a year, for six weeks at a time.

It has to be confessed, however, that there are cases especially of the sclerotic character, which, in spite of all treatment, advance until a condition of almost total deafness has been reached. In a very few instances local treatment seems to have rather an injurious influence. Where the deafness is but slight, and where objective examination of the ear shows no apparent morbid change, local treatment, even by simple inflation, should not be attempted.

If by treatment the surgeon is able to check the morbid processes, although no actual improvement in the hearing has been gained, he not merely saves the hearing power which remains, but he also diminishes the tendency of the good ear to become affected (see p. 308). We have to add that, while no improvement in the hearing or relief to the sounds in the ear may result from treatment, the patient in some cases finds relief from the nervous symptoms, which are frequently complained of in connection with this affection.

Attention to the nasal and pharyngeal mucous membrane—the *second* part of the treatment of chronic dry catarrh of the middle ear—must never be omitted by the surgeon. This region should be carefully examined in every case, and any morbid condition which may exist properly treated. The treatment of the naso-pharyngeal mucous membrane is sometimes of even greater value than the purely aural treatment, and has frequently to be continued after the latter has ceased. The student is referred to the chapter on diseases of the nose and throat, and specially to the treatment of chronic catarrh of this mucous membrane (p. 80), for a full consideration of this subject.

Constitutional Treatment is of use in chronic catarrh only when a cachectic condition exists, such as the strumous, the tubercular, the anæmic, or the syphilitic diathesis (f. 91 to 107). The condition of the digestive system should be inquired into, and any defect remedied. This, however, belongs to the domain of general medicine.

Hygiene is of importance in the prevention and treatment of this disease. This subject has been already considered in the chapter on methods of treatment at page 147.

CHAPTER III.

SUPPURATIVE DISEASES OF THE MIDDLE EAR.

I. Acute Suppurative Inflammation of the Middle Ear.

Syn.—Acute Perforative Inflammation of the Middle Ear; Otitis Media Purulenta Acuta; Acute Purulent Ear Catarrh (*von Tröltsch*); *Acute Suppuration of the Middle Ear* (*Roosa*).

Pathology.—This is a very prevalent form of ear disease. In its earlier stages it presents a great resemblance to the acute non-suppurative inflammation. In the suppurative form, however, the inflammation and swelling are more intense, the deeper layers of the mucous membrane being more affected, while the exudation is more purulent in character, although it generally also contains a variable proportion of mucus with some admixture of blood and epithelial cells. This form of inflammation is, however, distinguished from the non-suppurative by its tendency to softening, ulceration, and destruction, and by its being *always attended by perforation of the tympanic membrane.* The adjoining parts of the ear, the external auditory canal on the one side, and the labyrinth on the other, frequently participate more or less in the inflammatory process. In the labyrinth, while this participation may simply consist of transient hyperæmia, with perhaps serous exudation, there may, on the other hand, be destructive purulent formation (Panotitis) leading to total and permanent loss of hearing. The disease is usually confined to one ear, although both may be affected, especially in the exanthematous diseases.

Causes.—The causes are, in many cases, the same as those which give rise to the acute non-suppurative disease. Cold, acting from the direction of the external auditory canal, and naso-pharyngeal catarrhs are very common causes. It frequently originates in the exanthematous diseases, *especially scarlet fever.* Scarlet fever, complicated with or followed by diphtheria,* is apt to give rise to a most destructive type of the disease. It is much more common in childhoood than in adult years. It prevails more in cold, windy, or damp weather, than in warm, dry, summer weather. The irritation of teething, propagated by reflex action to the middle ear, is probably responsible for many cases occurring during infancy. The strumous or tubercular states of constitution also tend to produce it. As in nearly all diseases of the ear, hereditary tendency plays an important part in the causation. When the mucous membrane of the middle ear is already in a morbid condition, acute suppurative inflammation may be excited by some fresh irritation, and it thus not unfrequently arises in the course of *chronic* suppurative inflammation of the middle ear, or in cases of "dry perforation," remaining after the secreting process has passed away, when it leads to a renewal of the old "otorrhœa." It may also be due to the extension of an inflammatory process originating in the external auditory canal or tympanic membrane. Traumatic injury, the presence of foreign bodies, or efforts made to remove them, the introduction of caustic substances, the operation of paracentesis, or the propulsion of fluid through the Eustachian tube into the cavity of the tympanum, may excite this disease.

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*See "Ueber den Scharlach in seinen Beziehungen zum Gehörorgan,' von Alb. Burckhardt-Merian, in Volkmann's Sammlung, No. 182.

Subjective Symptoms.—The description of the subjective symptoms in acute non-suppurative inflammation (p. 273) is almost completely applicable here. If they differ at all, the difference is only one of degree. In the purulent inflammation the pain and other subjective symptoms may be more intense, and the feverishness more marked. The disturbance of the sensorium is here also probably more frequently met with, and is more severe. On the other hand, cases are met with, where there is neither pain nor general disturbance of the system, and where the first indication of the disease is a sense of moisture in, or discharge of matter from, the ear. This peculiarity is frequently observed in persons suffering from tubercular disease.

Objective Symptoms.—In the stage before perforation, the appearances of the membrane are almost identical with those described in the non-suppurative form (see p. 275). The difference, as in the subjective symptoms, is simply one of degree. The redness is often more intense and uniform with frequently a bluish or yellowish tinge. There may be localized saccules as in the non-suppurative inflammation (Fig. 81). The upper and back part of the membrane is usually the most strikingly changed portion, presenting a moist red bulging, having perhaps a yellowish spot in the centre (Fig. 82). The walls of the external auditory canal are usually somewhat injected and swollen, while the soft parts over the mastoid process are frequently œdematous or even reddened. The glands behind, below, and in front of the ear are also generally swollen and tender.

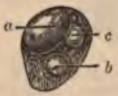

FIG. 81.

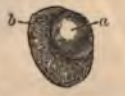

FIG. 82.

FIG. 81.—Appearance of right tympanic membrane in second stage of acute myringitis—*a*, large interlamellar abscess at upper and back part of membrane; *b* and *c*, smaller interlamellar abscesses.

FIG. 82.—Saccular bulging projecting from the upper and back part of the left tympanic membrane in acute suppurative inflammation of left middle ear—*a*, bulging; *b*, inflamed membrane in front.

When the membrane becomes perforated, the canal of the ear is found to contain secretion, which has escaped from the middle ear. In quantity this varies in different cases from a slight moisture, which does not escape from the outer orifice of the ear, to a constant flow of fluid. At first the discharge may be very thin and copious, resembling yellowish clear serum, becoming afterwards more purulent in character. Most frequently, however, the canal is occupied with mucopurulent secretion, the mucus and the pus being in varying proportions in different cases, and in the same case at different times. Plates of sodden epidermis are often found adhering to the walls of the inner end of the canal or to the tympanic membrane. On the removal of the secretion by syringing and wiping, the membrane is found to be very red and swollen, while its normal projections and concavities are effaced, and abnormal bulgings may be seen. The perforation takes place most frequently in the centre of the posterior half of the membrane, when it sometimes appears as a sharply defined black spot (Fig. 83). Being, however, at first usually small and with more of the character of a minute cleft, it is often difficult, or even impossible, in ordinary circumstances to distinguish it in the swollen inflamed tissue. By inspecting the membrane, however, during inflation of the middle ear, as by Valsalva's experiment, the situation of the perforation will often be indicated by the visible propulsion of secretion and air bubbles through a minute depression in the membrane, with a hissing sound. Sometimes during inflation we notice a drop of thick secretion appearing at the orifice, the drop passing in again with the cessation of the effort of inflation. In this case the perforation is usually situated in the summit of a localized

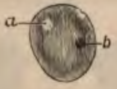

Fig. 83.—Perforation in left tympanic membrane during acute suppuration of middle ear—*a*, short process of malleus; *b*, perforation.

nipple-shaped swelling of the membrane. For a fuller description of the methods of distinguishing a perforation in the membrane see page 352.

Course.—The duration of the *first* stage—the interval between the beginning of the symptoms and the rupture of the membrane—presents many varieties in different cases. It may be as short as a few hours or as long as two weeks. In most cases, however, the rupture takes place in from three to four days. In adults the rupture may be delayed owing to the membrane having previously undergone morbid thickening, or become the seat of calcareous deposition. In children the tympanic membrane is normally thicker than in the adult, and therefore offers resistance for a longer time to the pressure of secretion pent up in the tympanic cavity. On the other hand, the peculiarity of the Eustachian tube in a child is more favourable than in the adult to the escape of secretion into the pharnyx. The rupture may take place by ulceration of the layers of the membrane, or the membrane may be so thinned and weakened by the pressure of the fluid and the softening effect of the inflammation, that a slight additional pressure, such as may take place during coughing or sneezing, is sufficient to burst it. A hissing sound in the ear and a discharge of fluid often tinged with blood, usually signalize the rupture, while marked relief to the pain and the other subjective symptoms is, in most cases, immediately experienced. This relief, in children, is often very remarkable both in the completeness and suddenness with which the subjective symptoms disappear. Sometimes, however, little or no effect in relieving the pain follows the rupture, and this is probably owing to the intensity of the inflammatory process.

The duration of the *second* stage, from the rupture of the membrane to the healing of the perforation, varies from three or four days to six or eight weeks. In many cases cicatrization takes place within two weeks; but the general health, the habits of life, and especially the character of the treatment, influence very materially the duration of this stage. The discharge from the ear is usually very copious at first but it gradually becomes less, while the intensity of the subjective sounds and the degree of acuteness of hearing frequently fluctuate, although they gradually improve with the subsidence of the swelling and secretion. Exacerbations of the inflammation, manifesting themselves by increase of the pain, subjective sounds and secretion, not unfrequently occur from exposure, but more commonly from irritating treatment. Retention of secretion, occurrence of inflammation of the external auditory canal (circumscribed or diffused), or periostitis of the mastoid process may complicate and prolong this stage.

The *third* stage, or that following the healing of the perforation, is characterized by a gradual disappearance of the redness and injected vessels, by the reappearance of the manubrium, and by the restoration of the normal polish and colour, till, after a time, not even a cicatrix may be discernable. On the other hand, a permanent cicatrix may be left behind (Fig. 84), or a localized opacity or calcareous deposition may remain ever afterwards. Defect of hearing or tinnitus aurium sometimes continues for a time after the healing of the perforation, and in a certain proportion of cases, either or both of these may be permanent, owing to the formation of adhesions or to permanent thickening of the mucous lining of the tympanic cavity.

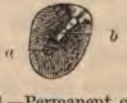

FIG. 84.—Permanent cicatrix in tympanic membrane, after acute suppurative inflammation of the middle ear—*a*, cicatrix; *b*, manubrium.

Consequences.—1. The establishment of a chronic discharge from the ear (chronic suppurative inflammation of the middle ear) is a frequent result, which may prove the annoyance of a lifetime, and lead to a serious issue. Such a course is most frequent, when it is associated in its origin with a zymotic disease, especially with scarlet fever, or when it occurs in a strumous or tubercular person, or in one having a strong hereditary tendency to ear disease. 2. Very serious or even total deafness may follow. Serious and irreparable injury to the ear may ensue in a very short time, especially in cases associated with scarlet fever (particularly with diphtheritic scarlet fever). In these cases the tympanic membrane may be completely destroyed in a very short time, and in some instances there is destruction of the ossicular articulations with escape of one or more of the ossicula, or total deafness may be the result of serious and permanent injury to the labyrinth. A not inconsiderable proportion of cases of acquired deaf-mutism is the result of rapidly destructive forms of acute suppurative inflammation of the middle ear. 3. Acute caries or necrosis of the osseous walls of the middle ear may arise. Mastoid periostitis with suppuration behind the ear, with or without caries or necrosis, is a not unfrequent consequence of the disease. 4. It may lead to facial paralysis. The prospects of recovery from facial paralysis, when it occurs during this disease, are much more favourable than when it occurs in the course of chronic suppurative inflammation. 5. A fatal termination may ensue. This is much rarer than in the chronic disease; but death may occur by extension of the inflammatory process to the interior of the cranium, or by pressure inwards of the purulent secretion, when it is unable to make its way through the tympanic membrane. In children the extension of the inflammatory process through the petrosquamosal fissure probably leads in an undetermined proportion of cases to fatal intra-cranial mischief.

Diagnosis.—The points of distinction between the first stage of this affection and acute myringitis are the same as those mentioned in the diagnosis of acute myringitis (see p. 238). Between the non-suppurative and the first stage of the suppurative inflammation there are no completely reliable points of distinction. The presence of the latter disease may be suspected, if the reactive symptoms are very intense, if there is great bulging outwards of the membrane, and if that bulging has a yellowish or yellowish-green colour. The diagnosis of the stage after perforation depends upon the proof of the existence of a perforation (see p. 352). Like the non-perforative form, this affection may be confounded with toothache, neuralgia, meningitis, or congestion of the brain (see p. 278). An objective examination will at once remove any doubt. Obscure illnesses in young children consisting of feverishness, irritability, and symptoms of cerebral disturbance are sometimes explained by the ultimate appearance of a discharge from the ear.

Prognosis.—The prognosis of speedy recovery may be made, 1. if no strong hereditary tendency to ear disease exists; 2. if the organ has been previously healthy; 3. if the attack has not arisen from any constitutional or zymotic disease; 4. if the first stage has been short, the discharge rapidly becoming less, with no recurrence of pain or subjective sounds in the ear; and, 5. if appropriate treatment has been carried out. On the other hand the prognosis is unfavourable as regards quick recovery, 1. if strong hereditary tendency exists, and if the organ has been previously diseased, as by chronic adhesive catarrh; 2. if the disease has originated in scarlet fever, or tubercular disease, or if it has occurred in a markedly scrofulous or syphilitic patient; 3. if the aperture is extremely small and situated on a nipple-shaped eminence, while the secretion is very thick, and great dlfficuity is also experienced in inflating the middle ear; 4. if there is repeated recurrence of severe pain, noises in the ear, and aggravations in the deafness; 5. if the discharge is unabated after two or three weeks, and generally tinged with blood (indicating granulations, polypi, or diseased bone); 6. if there is rapid and great destruction of the tympanic membrane, and especially if there has been escape of any of the ossicula; 7. if there are symptoms of mastoid disease.

Treatment.—To avoid repetition, the reader is requested to turn to the description of the treatment of non-perforative inflammation (p. 279), as, with the exception of the remarks on the introduction of fluids into the ear, and on incising the membrane, the whole of that description is applicable to the present disease. The introduction of warm liquids into the ear and the application of poultices are more admissible here than in the non-perforative inflammation. Simple warm water, frequently poured into the ear, as described under the head of acute otitis externa (p. 199), is often a very efficacious means of relieving the pain. In an adult ten drops of the solution of morphia, warmed and instilled into the ear every three or four hours, has a still more sedative effect. Hot poultices are to be used under the same circumstances and with the same precautions as in otitis externa diffusa (see p. 199).

When there is distinct evidence of a purulent collection in the middle ear, *incision of the membrane* should be performed. When we have such a cavity as the tympanum filled with pus, whose walls consist partly of bone and partly of fibrous tissue, situated in the immediate neighbourhood of most important structures, a prompt and effectual opening with the knife is simply in accordance with the clearest surgical principles, and is of importance not only for the future healthy function of the organ, but also for the safety of the patient's life. This is eminently true, when, as is often the case in scarlet fever, the morbid secreting process is rapidly and constantly going on, and when destruction of essential parts of the organ of hearing may be completed in a very short time. The incision of the membrane decidedly alleviates the pain, limits the evil effects of pressure upon the ossicular chain and the walls of the middle ear, and obviates such a loss of the substance of the membrane as would take place if we waited for spontaneous rupture. The operation is of especial value in those cases of purulent collection in the middle ear, where the membrane is thickened and more unyielding in consequence of previous disease, and where, therefore, the process of spontaneous rupture is rendered more difficult. In such cases, timely incision of the membrane may prevent, we may reasonably suppose, the extension of the disease to the labyrinth or to the meninges. It is to be noted that, when the membrane has become thickened, its rigidity and opacity may obscure very much the signs of purulent collection. If great pain exists in the ear, and if there be marked tenderness over the mastoid process, with shooting pains over the side of the head, and decided impairment of hearing, an exploratory opening should be made in the membrane, even although no bulging or characteristic change of appearance points out the existence of matter behind it.

When the membrane has become perforated either spontaneously or artificially, effective means should be taken to evacuate as completely as possible the tympanic cavity. This is to be done both by syringing and by inflation. The following plan may be generally pursued. The ear should be syringed gently with a warm watery solution of boracic acid, then inflated by Politzer's method, or any of its modifications, when more secretion will probably be forced through the perforation into the external auditory canal. The canal of the ear should again be syringed, and then dried with absorbent cotton. The inflation not only helps in forcing the secretion outwards through the perforation, but improves the hearing, and counteracts the formation of adhesions. In favourable cases the mere cleansing of the ear by syringing with the solution once or twice a day, and afterwards drying, will suffice to bring the discharge to an end and to heal the perforation in a week or two. But, if the discharge persists beyond that time, the treatment by insufflation of small quantities of finely powdered boracic acid should be employed. The treatment by syringing, inflation, and insufflation of boracic acid is probably more quickly successful than any other form of treatment, and it is attended by less likelihood of recurrence of the inflammation or by inflammatory complications in the external auditory canal during the course of recovery. If this mode of treatment fails, *astringents* should then be tried. The best form of astringent is a warm solution of sulphate of zinc (f. 35) applied as follows:—After cleansing the ear by syringing with warm water and drying with absorbent cotton, fifteen drops of the warmed solution are poured into the ear, and allowed to remain for ten minutes, during which Valsalva's experiment is to be performed several times. The canal of the ear is to be finally dried, and a long plug of boracic cotton introduced, in order to assist in keeping the walls of the canal dry. This process is to be repeated twice a day. If after a week or ten days no improvement is observed, we may substitute a solution of acetate of lead (f. 32) for the sulphate of zinc. This is sometimes successful, when the sulphate of zinc has failed. If the discharge persists after the foregoing remedies, and if none of the complications about to be mentioned are present, the nitrate of silver treatment described at p. 368 should be tried. It is less likely to irritate the ear even in painful states of the organ, than simple astringents, and is sometimes very efficacious.

Certain peculiarities may exist rendering the case extremely obstinate. (1) The purulent secretion may be very thick, while the perforation in the membrane is small. We should endeavour to thin the secretion by pouring a warm weak solution of bicarbonate of soda into the ear, and allowing it to remain there for a few minutes, during which the tragus is frequently pressed in upon the fluid. This should be repeated every eight hours for two or three days. In many of the cases, however, which are obstinate from this cause, the perforation should be artificially enlarged with the paracentesis knife (p. 116), after which advantageous results will frequently follow the other methods of treatment. (2) When the perforation is on the summit of a nipple-shaped projection, the case often proves peculiarly obstinate to ordinary treatment. For this condition, and in cases where there is great pain in the ear and mastoid process after perforation, Politzer speaks highly of the injection several times of warm water into the middle ear through the Eustachian catheter. (3) In some cases granulations, or even polypi, spring up very rapidly, and excite the continuance of the purulent secretion. For granulations several applications of the solid nitrate of silver, or of strong perchloride of iron, in conjunction with the insufflation of boracic acid, lead to their quick disappearance. Polypi should be removed with Wilde's snare, and subsequent cauterization, as described at p. 383. In children, when granulations or polypi spring rapidly up in acute suppurative inflammation, the treatment by diluted alcohol (see p. 369) is more practicable than operative or caustic treatment, and may prove, by prolonged use, successful.

If inflammation of the mastoid process should supervene at any stage of the disease, the treatment described at p. 402 should be at once resorted to.

When defective hearing, or tinnitus in the ear, remains after the healing of the perforation, repeated inflation by Politzer's method or with the catheter is to be carried out just as in the treatment of the later stages of the non-suppurative form of inflammation.

The nasal passages and pharynx always demand careful treatment, especially when the disease is connected with scarlet fever. The reader is referred to the treatment of the catarrhs of the nasal passages and pharynx.

While the acute symptoms are present, rest and quiet in the house, especially during winter time, are frequently necessary and always helpful to quick recovery.

II. Chronic Suppurative Inflammation of the Middle Ear.

Syn.—Chronic Perforative Inflammation of the Middle Ear; Otitis Media Suppurativa Chronica; Chronic Purulent Ear Catarrh (von Tröltsch); Chronic Suppuration of the Middle Ear (Roosa); "Otorrhœa."

This is the most frequent and probably the most important disease of the ear. It is commonly called "Otorrhœa," or "running ear," from its most prominent symptom. Of 1088 cases of ear diseases recorded by the writer, and treated in the Glasgow Western Infirmary, 408 cases, or 37½ per cent. of the whole, consisted of this affection or of its consequences.

Pathology.—The mucous membrane of the middle ear, in whole or in part, is in a state of chronic inflammation, with the formation of purulent or muco-purulent matter, which escapes through an aperture in the tympanic membrane. It is usually most pronounced in the tympanic cavity, the mucous membrane of which is red, and may be swollen to several times its normal thickness. In cases which are not of very long duration the swelling is due to dilated vessels and interstitial serous or cellular infiltration, chiefly in the sub-epithelial tissue. The epithelial lining is usually gone, and the surface presents a red, soft, granular or smooth appearance. From this surface granular or papillary excrescences or polypi may project as the result of hyperplastic growth. When the disease has continued for a length of time, there is also frequently a new formation of connective-tissue elements, leading to dense thickenings, adhesions, or cicatrices. Calcification or ossification not unfrequently takes place. In a very advanced stage the mucous membrane may become pale or even white from atrophy. The morbid process may also lead to serious changes in the osseous walls and ossicula, such as erosion or caries, necrosis and exfoliation, or thickening and hyperostosis.

The tympanic membrane is almost always perforated. The perforation may vary from the size of a pin point to that of almost the whole membrane. The part of the membrane remaining is usually thickened owing to the new formation of connective-tissue in all its layers, but chiefly in the cutaneous and mucous layers. There is not infrequently also calcareous deposition in the membrane, while atrophic changes are found at certain stages.

In some very exceptional cases the tympanic membrane is not perforated, owing probably to extreme previous thickening of its layers. In such circumstances the purulent secretion escapes either by the Eustachian tube or by an opening in the cortical part of the mastoid cells behind the auricle, or in the osseous part of the external auditory canal. Purulent collections in the middle ear unattended by perforation of the membrane seem to be relatively common in new-born or very young infants (von Tröltsch).

Causes.—In most cases the disease originates in acute suppurative inflammation of the middle ear. Frequently, however, there is no history of pain. A large number of cases can be traced back to an attack of scarlet fever or measles. When the acute affection occurs in a patient of tubercular, scrofulous, or debilitated constitution, or in a person living under bad hygienic conditions, it is very liable to pass into the chronic state. The disease is also often maintained by a morbid state of the nasal and pharyngeal mucous membrane. The anatomical peculiarities of the middle ear, by favouring the retention of secretion, encourage the transition of the acute affection into the chronic condition. Inattention to the treatment of the early stage is also frequently responsible for the establishment of the chronic form. This neglect favours the constant accumulation, presence, and decomposition of the purulent secretion, with in many cases the occurrence of granulations, polypi, caries, necrosis, or extension of the suppurating process to the mastoid cells. In some cases the disease is the result of the extension of a chronic otitis externa or of a chronic myringitis to the middle ear. It is met with at all ages, but frequently begins in childhood, originating in by far the greatest number of cases before the age of fifteen years.

Subjective Symptoms.—Probably nothing so contributes to the neglect by patients of this disease as the *frequent absence of painful subjective symptoms.* In most cases there is either no pain in the whole course of the disease, or, if pain is experienced, it is at long intervals, and is due to some complication. Thus, obstruction to the exit of the secretion owing to temporary closure of the perforation, polypi, or contraction of the external auditory canal may excite severe pain in the ear. Or an acute exacerbation of the purulent inflammation, or an intercurrent attack of diffuse or circumscribed inflammation of the external auditory canal may for a time excite great pain. Heavy dull pain in the head, chiefly in the region supplied by the trigeminus, is sometimes complained of, particularly by anæmic and weakly persons. When there is caries, the pain in the ear and head may be very severe and almost constant. In cases attended by severe headache there is probably a partial extension of the inflammatory process to the dura mater or venous sinuses. Frequent attacks of slight giddiness are experienced by some patients.

Subjective sounds in the ear are complained of in only a comparatively small proportion of cases. The chronic purulent disease presents in this respect a striking contrast to the chronic adhesive catarrh. Probably the fact of a perforation of the membrane being always present, preventing the effects of rarefaction of the air in the tympanic cavity, accounts for the comparative infrequency of *tinnitus aurium*. When this symptom is present, it has often the character of that met with in the acute form of the disease, or of that in chronic adhesive catarrh.

The degree of *impairment of hearing* varies from very slight and unobserved dulness, to almost complete loss of hearing. It is, in the same person, liable to fluctuation owing to changes in the quantity and in the situation of the secretion and in the degree of swelling of the mucous membrane, caused by changes of temperature, states of the weather, &c. It is commonly believed that the defect of hearing is mainly the result of the perforation of the tympanic membrane. This is a mistake. There are many persons with perforation of the membrane even on both sides, whose hearing is not so much impaired as to be noticed by their friends. The deafness is only partially, and in a comparatively slight degree, caused by the hole in the membrane. It is chiefly due to changes in the tympanic cavity.

These changes are (1) a swollen or thickened condition of the mucous membrane covering the ossicles and the fenestral membranes or recesses leading thereto; (2) the presence of fluid or inspissated secretion upon these parts; (3) adhesions or bands between the ossicula and walls of the tympanum, especially between the stapes and walls of its recess or those which form the entrance to the fenestra rotunda; (4) rigidity of the joints of the ossicula, loss of one or more of the ossicula, or loss of continuity in the ossicular chain; (5) a concomitant affection of the labyrinth. In short, if there is a freely movable stapes with normal fenestral membranes, the conducting function of the ear may not be seriously impaired, although the membrane is partially destroyed.

Hearing by osseous conduction is usually very good, provided the labyrinth and nerve are unaffected. If the disease is limited to one side, the vibrating tuning-fork applied to the middle line of the head is heard more loudly on the *affected* side.

Patients occasionally complain of impaired or depraved sense of taste. The investigations of Urbantschitsch and others show that impairment of the sense of taste very commonly exists, although rarely complained of by patients. Occasionally patients speak of a very disagreeable sense of taste and smell, which they attribute to the passing of the fœtid purulent matter into the pharynx.

Objective Symptoms.—On examination of the external auditory canal a greater or less amount of *secretion* is found. This sometimes fills the canal, or it may be seen only at the inner end over the perforation or coating the membrane. It may be so small in quantity as never to appear at the outer orifice of the ear, so that the patient may not be aware of the existence of a suppurating process in the ear. The character of the secretion presents great varieties in different cases, and in the same case at different times. It may be altogether purulent, white or yellowish in colour, and mix uniformly with water. Or the mucous element may predominate, the secretion being composed of strings or flakes, which do not dissolve in water, but remain separate from it. This mucous secretion is sometimes so tenacious, that there is considerable difficulty in completely removing it from the deep parts of the ear. Again, the secretion may be rendered thin and less opaque owing to the pus being mixed with a considerable quantity of serum. The secretion may be tinged with blood, especially when there are granulations or polypi. In caries or necrosis the discharge is sometimes like flesh rinsings (Politzer), and has a very irritating quality. If the secretion is small in quantity, and if there is abundant formation of cerumen, the discharge may be mistaken by the patient for thin wax. Dried masses are sometimes found filling the inner end of the canal and adhering to the upper and back wall. In such cases the dryness of the secretion is due either to its small amount, or to the active process having ceased altogether. After removing the dry crusts, small granulations covered with pus may be found within. These dried accumulations are sometimes composed of epidermic or epithelial laminated masses, which may have a shining pearly appearance from the presence of cholestearine between the plates.

The discharge has frequently an offensive smell, especially if regular cleansing has been neglected, although even this is sometimes not sufficient to prevent the bad smell. The odour is particularly offensive when there is diseased bone, or when the secretion remains mixed with the ceruminous and oily matter of the canal. In some cases the odour is most disgusting, and infects the air in the neighbourhood of the patient. In very old cases it frequently resembles the odour from rotten cheese, or the odour of old cheese without distinct putridity.

In order to ascertain by examination the condition of the walls of the canal and of the tympanic membrane we must, unless the discharge is very slight, syringe the ear, and afterwards dry the parts carefully with absorbent cotton. If there is very little discharge, simply wiping it away with cotton is to be preferred to syringing. The cutaneous lining of the canal is, in many cases, reddish and swollen, from the irritating action of the secretion. We sometimes find, in consequence of the acrid or even caustic properties which the secretion may possess, the skin of the canal, especially of the floor, excoriated, or even in rarer cases ulcerated. The excoriation may extend to the outer parts of the ear as far as the lobule. Eczema of the auricle may result from such irritation. The calibre of the canal may be considerably contracted owing to swelling or thickening of the cutaneous lining, or to hyperostosis.

The tympanic membrane is always found in a pathological condition. In the first place there is, with extremely few exceptions, an *aperture in the membrane* forming an abnormal communication between the external auditory canal and the middle ear. This aperture may be no larger than a very small cleft, or a pin-point (Fig. 83), or there may be almost complete destruction of the membrane (Fig. 85). There is probably never *complete* loss of the membrane. Even in the worst cases, which have generally their origin in scarlet fever, a portion of the upper segment and a narrow rim all round usually remain, although these remnants may be difficult to see, owing to the swollen state of the tissues. Between the pin-point perforation and almost complete destruction we find great varieties in the extent of loss of the membrane. There is usually only one perforation, but occasionally two are found

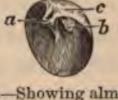

FIG. 85.—Showing almost complete loss of membrane—*a*, short process; *b*, articulation of incus with stapes; *c*, remnant of membrane.

(Fig. 86), and very rarely three. When two exist, it is common to find them separated by the manubrium, and sometimes by a narrow bridge of membrane extending from the lower end of the manubrium to the inferior edge of the membrane.

Probably the most common situation in which a perforation is found is the lower half of the membrane, and especially in the antero-inferior part. Perforations are, however, not at all unfrequent in the upper part, especially when the source of the secretion is in the upper tympanic cavity, above the level of the upper edge of the membrane. The perforation is then in the membrana flaccida. The aperture may in these cases be exceedingly small, and situated close to the upper edge, or the whole of the membrana flaccida may be removed, along with, in some cases, the postero-superior part of the rest of the membrane (Fig. 87). The peripheral part of the tympanic membrane, with the exception of the membrana flaccida, being the strongest and thickest part, most frequently remains intact, and there is therefore usually, though not invariably, some of it left between the perforation and the bone. When the handle of the malleus seems to form part of the edge of a perforation, there is, in most cases, really a border of membrane between the bone and the perforation.

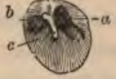

FIG. 86.

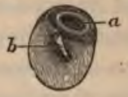

FIG. 87.

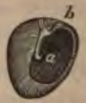

FIG. 88.

FIG. 86.—Double perforation in left tympanic membrane—*a*, larger perforation behind manubrium; *b*, smaller perforation in front of manubrium; *c*, lower end of manubrium.

FIG. 87.—Destruction of membrana flaccida—*a*, aperture in membrana flaccida; *b*, manubrium pushed down and shortened.

FIG. 88.—Large oval perforation in anterior half of tympanic membrane—*a*, Near centre of perforation; *b*, short process of malleus.

Perforations in the tympanic membrane are most frequently roundish or oval in form (Fig. 88). When the lower end of the manubrium projects into the gap, the latter has a kidney-shape (Fig. 89) with the hilus upwards. Rarely, there is found an oblique fistulous kind of opening through the membrane.

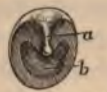

FIG. 89.

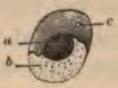

FIG. 90.

FIG. 89.—Kidney-shaped perforation—*a*, manubrium; *b*, perforation.

FIG. 90.—Round perforation in centre of right tympanic membrane. The upper edge of the perforation is adherent to the inner wall of the tympanum. The lower half of remnant of membrane is converted into a calcareous mass—*a*, perforation; *b*, calcareous mass; *c*, portion of short process of malleus.

The portion of membrane which remains presents various appearances. It is sometimes congested, granular, and swollen. At other times it is greyish or whitish and hypertrophied. Sometimes there is a well-defined patch of calcareous deposition. The chalky patch is most frequently seen after the purulent secreting process has ceased, and is usually in some part of the membrane between the manubrium and the edge of the membrane. There may be in the one membrane several patches of calcareous deposition, and even the whole of the remnant of the membrane is sometimes found converted into a chalky mass. The edge of the perforation is often red and granular, and in contact with, or even adhering to, the inner wall of the tympanum or one of the ossicula (Fig. 90).

The mucous membrane of the tympanic cavity, as seen through the perforation, is generally red and swollen or even hypertrophied, and the surface may be either smooth or granular. Sometimes, especially in very old cases, it is thin and yellowish grey or whitish in colour. Part of the exposed mucous membrane may be red and swollen and part grey and thinned. When the perforation is very small, it usually appears as a dark spot, surrounded by red and swollen membrane, the manubrium being invisible owing to the altered cutaneous layer covering it (Fig. 83).

The part of the cavity of the tympanum exposed to view depends upon the size and position of the gap in the membrane. The mucous lining of the promontory immediately in front of and below the umbo is very frequently laid bare. In the postero-inferior quadrant, we often see the anterior rounded edge of the opening into the fenestra rotunda, and behind that the opening itself is seen as a dark semilunar depression directed backwards (Fig. 91). When the lower part of the membrane is destroyed, the irregular tesselated appearance of the floor comes under observation, while, if the loss of membrane is in the antero-superior part, the portion of the inner wall corresponding with the position of the carotid artery and, more rarely, a part of the entrance to the Eustachian tube are exposed.

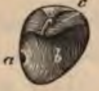

FIG. 91.

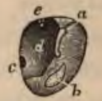

FIG. 92.

FIG. 91.—Large destruction of right tympanic membrane, showing promontory and entrance to fenestra rotunda, only upper part of membrane with portion of manubrium remaining—*a*, entrance to fenestra rotunda; *b*, front of promontory; *c*, part of membrane remaining with upper half of manubrium.

FIG 92.—Large destruction of right tympanic membrane, exposing portion of stapes, entrance to fenestra rotunda, and promontory—*a*, short process of malleus; *b*, calcareous deposition in part of membrane remaining; *c*, entrance to fenestra rotunda; *d*, above and in front of promontory; *e*, head and crura of stapes.

One or more of the ossicula may be clearly seen through the aperture. When the membrana flaccida is destroyed, the neck of the malleus and sometimes a part of its head are brought into view. In destruction of the upper and back part of the membrane we frequently see a part of the stapes, which may be covered partially with reddened mucous membrane. The knob-shaped head may be alone seen, or, in addition, one or other of the processes, particularly the posterior, may be visible (Fig 92). The tendon of the stapedius muscle is sometimes exposed, extending from the head of the stapes towards the back wall of the tympanum. The long process of the incus and its articulation with the head of the stapes are occasionally seen, although, even when the stapes is exposed, this process of the incus is usually wanting. Rarely the long process of the incus is exposed to view, while no part of the stapes is visible. The full length of the manubrium is often very distinct, and apparently thicker than in the normal condition. Its lower end is frequently in contact with the inner wall of the tympanum, and may even be immovably fixed to it by adhesions. In many cases, however, it is shortened, owing to carious destruction of the lower end (Fig. 85). Sometimes nothing remains but the short process and a small part immediately below. But the manubrium may be invisible or appear shortened, not because of its destruction, but because of displacement upwards. This is due to its having lost the support of the tympanic membrane, when the tensor tympani, being no longer antagonized, pulls the malleus so far upwards and inwards, that it comes to lie in the upper tympanic cavity, and so disappears from view.

Lastly, enlargement and tenderness of the glands in the neighbourhood of the ear are often found. The cervical glands below the ear, the parotid, and the glands over the mastoid process may be affected in this way. Suppuration, especially in the cervical glands, not unfrequently results.

Course.—The course of the secreting stage of chronic purulent inflammation of the middle ear is usually a very prolonged one, and is attended by many risks of complications, which may be of a very serious character. Some cases terminate in a few months, a large number only after many years, while a certain proportion of cases continue for a lifetime. While the discharge, during the whole course of the disease, may be constant, there are, in a considerable number, occasional intermissions of days, weeks, or even months. The discharge is usually aggravated in spring or early winter, or when the patient suffers from "cold in the head." The gap in the membrane may remain unaltered for many years, or it may diminish somewhat, but sometimes it gradually increases, until almost the whole of the membrane is destroyed. We meet with cases, however, in which, after the discharge has continued for many years, the perforation is no larger than a pin hole. In the course of the disease one or more of the ossicles may come away, the incus most frequently and the stapes most rarely. Very painful symptoms may come on, owing to the supervention of an acute inflammatory attack, when the discharge usually stops altogether, or becomes markedly diminished for a short time. This cessation of the discharge is not the *cause*, as is by some erroneously supposed, but the *effect* of the acute inflammation. Acute diffuse or circumscribed inflammation of the external auditory canal is not an unfrequent complication, and is attended usually by severe pain.

The persistence of the purulent secreting process is due to several causes. 1st, The smallness or unfavourable position of the perforation, preventing the escape of the purulent secretion from the tympanic cavity. 2nd, Retention, accumulation, and decomposition of the purulent secretion, when its source is in the upper tympanic cavity or antrum mastoideum. 3rd, The formation of exuberant granulations or polypi; this not only perpetuates the discharge, but renders it more profuse. 4th, The formation of adhesions or septa, which may partition the middle ear into several spaces retaining or enclosing part of the secretion, and thus increasing or aggravating the disease. 5th, Caries, necrosis, or hyperostosis of the osseous walls of the ear may perpetuate the disease. The cause of the disease and the constitutional condition of the patient exercise a marked influence on the duration of the discharge. Those cases which arise from scarlet fever are usually more persistent than those originating in cold; while the scrofulous, tubercular, and syphilitic diatheses always exert a very considerable effect upon the course of the disease.

Probably, however, the most important factor in keeping up this affection is the *neglect of treatment* and especially of proper and thorough cleansing. It is a common experience of those specially engaged in the practice of aural surgery to find persons, who have suffered from this disease for many years without the smallest effort having been made to cure it. This is mainly due to the usual absence of pain or disturbing subjective symptoms, to the fact that the morbid processes are concealed from view, to ignorance of the possible consequences of the disease, and to the advice often given by the practitioner to "leave it alone."

The purulent process, after a lapse of time, varying from several months to many years, may *permanently cease*, leaving, however, the organ more or less injured. We may conveniently distinguish three groups of cases to illustrate the various modes in which the process may terminate and the condition in which the organ is left. 1st, Those in which the chronic inflammation of the mucous membrane gradually subsides, with diminution and, ultimately, complete cessation of the secreting process, terminating in cicatrization of the perforation and recovery of the function of the organ. This course is by no means a rare one. 2nd, Those which terminate like the first group in cessation of the purulent process and complete cicatrization of the perforation, but where permanent damage to the hearing is left behind from thickening and rigidity of the mucous membrane, from adhesions or bands in the cavity of the tympanum, or from thickening, calcareous deposition in, or atrophy of, the tympanic membrane. 3rd, Where there is recovery from the chronic purulent process, but persistence of the perforation, the so-called "dry perforation," with more or less injury to the hearing, mainly from the same causes as in the second group.

Complete *healing by cicatrization* of a long existing perforation in the tympanic membrane is not at all unfrequent. While it is rare for almost total destruction of the membrane to end in the formation of a cicatrix, which completely fills up the gap, such a result has been observed. Small or moderate-sized perforations, however, not unfrequently heal, even after they have existed for many years. There is usually left behind a permanent cicatrix (Fig. 93), consisting of a thin layer of connective tissue having an outer epidermic and an inner epithelial covering. A cicatrix in the membrane is dark in colour, and its edge is sharply defined from the neighbouring membrane. It is much thinner than the normal membrane, and on that account is usually somewhat depressed below the level of the rest of the membrane. When the middle ear is inflated, or when the air in the external auditory canal is rarefied, the cicatrix is seen to bulge out somewhat like a small bladder, which, however, collapses immediately afterwards. The membrane adjoining a cicatrix is frequently opaque and thickened, and it may be the seat of calcareous deposition (Fig. 94). This is usually white or whitish yellow in colour, semilunar in shape, and clearly demarcated from the neighbouring membrane. We may find several calcareous patches, and frequently one is seen in front of the handle of the malleus, and another behind. If the cicatrix is large, we may see through it part of the inner wall of the tympanum and

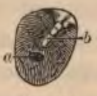

FIG. 93.

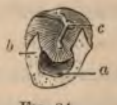

FIG. 94.

FIG. 93.—Permanent cicatrix in tympanic membrane, after acute suppurative inflammation of middle ear—*a*, cicatrix; *b*, manubrium.

FIG. 94.—Right tympanic membrane after long-continued suppurative process had passed away, showing cicatrix and large calcareous deposition—*a*, cicatrix; *b*, calcareous deposition; *c*, short process of malleus.

of the ossicula. The promontory, the opening into the fenestra rotunda, or the articulation of the incus and stapes, is in this case clearly seen, as in the atrophied membrane (Fig. 95). The cicatrix may in some cases form adhesions with these various parts. By the use of the pneumatic speculum we can readily ascertain whether a cicatrix is adherent or not. If we inspect the membrane during the act of suction, a bladder-like bulging of the cicatrix indicates non-adhesion, while immobility of the cicatrix and mobility of the rest of the membrane shows adhesion. It is sometimes found that, after a perforation has cicatrized, the hearing is less acute than before. This possibility should not, however, deter us from using every means to bring about healing. If the hearing is worse after cicatrization, it may ultimately improve either spontaneously or as the result of treatment similar to that employed for chronic adhesive catarrh.

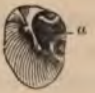

FIG. 95.

FIG. 95.—Left tympanic membrane in which there is atrophy of the postero-superior part—through the transparent atrophied portion, above, is seen the articulation of the incus and stapes; below, the rounded border of the entrance to the fenestra rotunda. The atrophied membrane lies in contact with these parts—a, centre of atrophied part of membrane.

In a considerable proportion of cases, however, the perforation remains open, the so-called "dry perforation," after the purulent secretion has ceased. We are not able to explain satisfactorily why in one person a perforation may completely cicatrize, while in another a perforation of equal size, and apparently under similar circumstances, may never cicatrize. It is to be noted, however, that cicatrization may take place years after the cure of the discharge. In these cases of permanent dry perforation, the edge of the perforation is usually thickened and callous, and has an epidermic covering. The mucous membrane of the tympanic cavity, especially of the promontory, as seen through the perforation, is generally dry, greyish, and shining, consisting of connective tissue of the nature of cicatricial tissue. The remnant of the membrane is here also frequently the seat of calcareous deposition, opaque thickenings, or circumscribed atrophy. When a permanent "dry perforation" remains, the patient is more exposed to attacks of acute suppurative inflammation than when cicatrization has closed the opening. This liability is due to loss of the protective power of the membrane exposing the tympanic mucous lining to injurious influences from without, such as cold wind, water trickling into the ear, &c. Adhesive processes, or formations of ligaments or bands of connective tissue, very frequently take place during some part of the course of a case of chronic purulent inflammation of the middle ear. From prolonged contact of soft, inflamed, granulating mucous surfaces, permanent adhesions may form, especially between the tympanic membrane and the inner wall of the tympanum, or between the tympanic membrane and the incus and stapes. Adhesions, bands, or cords may partition off the middle ear into two or more compartments, having no communication with each other. In this way we may have the upper tympanic space shut off from the lower, or the anterior part of the tympanum from the posterior. Membranous septa may in some instances completely shut off the antrum mastoideum, in others the Eustachian tube, from the cavity of the tympanum. In like manner the recess into the fenestra rotunda may be completely closed. Cords or bands may also bind the ossicular chain or individual bones of it, and so diminish or destroy their vibrating or conducting power. The stapes is in this way frequently bound to the walls of the fenestra ovalis or the handle of the malleus to the promontory. Cases are also met with, in which the fenestral recesses are filled with connective tissue, the stapes being thereby rendered absolutely unyielding, and access to the membrane of the fenestra rotunda shut off. Permanent dry perforation is quite compatible with fairly good hearing. There is not such severe or frequent fluctuation of the hearing as in the secreting stage, while there is not such a tendency to progressive aggravation of the deafness, or to implication of the labyrinth, as in the chronic non-suppurative forms.

A cicatrix does not necessarily cause impaired hearing. If large, or if adherent, there is usually more or less defective hearing, due in the first case to diminished tension of the membrane, and in the second to its binding the ossicula and impeding their vibrating power. Inflation in either case usually improves the hearing, at least for a time. Other kinds of adhesions, connecting bands or cords, or extensive formations of connective tissue have usually a more important influence in impairing the hearing than cicatrices. When they exist in the upper part of the tympanum, binding the ossicula to the walls of the cavity or to one another, the hearing may be very seriously decreased. Most serious deafness, which is sometimes total, is produced by thickenings, or connective tissue formations in the fenestræ, by complete binding down or anchylosis of the stapes in its fenestra, and by serious complication in the labyrinthine structures. It has also to be observed that, when total deafness exists in one ear as the result of chronic purulent disease, the other ear is apt in time to become gradually deaf owing to the invasion of chronic dry catarrh.

Consequences.—In describing the course of this disease, we have pointed out the changes and the effects produced upon the tympanic structures. There are other consequences and complications, which are often found to ensue, so important in their nature and demanding such full consideration, that they must be discussed separately and in detail in the following chapter. These consequences may be limited to the ear itself, or may extend to parts outside of the ear.

A. Consequences limited to the ear itself.

1. Polypi.
2. Caries and necrosis.
3. Formation of caseous and cholesteatomatous masses.
4. Acute periostitis over the mastoid process.
5. Acute suppurative inflammation in the mastoid cells.

B. Consequences affecting parts of the body outside the ear.

1. Facial paralysis.
2. Purulent meningitis and cerebral abscess.
3. Phlebitis and thrombosis.
4. Embolism. Metastatic abscesses. Pyæmia.
5. Tubercular disease.
6. Fatal hæmorrhage.

Diagnosis.—If a discharge from the ear has existed for a length of time, and if on examination the tympanic membrane is found to be perforated, the disease is chronic suppurative inflammation of the middle ear. There may, however, have been no discharge for years, and yet the deafness of which the patient complains may be due to this disease or to its effects on the middle ear. In this case the existence of a perforation or a cicatrix will indicate the original character of the affection. The diagnosis, therefore, depends very much upon the existence of a perforation in the tympanic membrane.

The *presence of a perforation* in the tympanic membrane is generally easy of recognition.

In the first place it may be said that, if a person has suffered from a purulent discharge from the ear for months or years, there is great probability of an opening in the membrane; while, if the discharge contains mucus, there is, undoubtedly an abnormal communication with the middle ear, and this communication will consist in nearly all cases of an opening in the tympanic membrane. We have already described the appearances and the usual situations of these perforations. We may here mention certain difficulties in the diagnosis of a perforation, which may present themselves. 1st, If it is very small, and in a membrane which is much reddened and swollen, and especially if it is situated in the lower and front part, which is often concealed by the bulging of the antero-inferior wall of the external auditory canal, there may be great difficulty in distinguishing the perforation by inspection alone: 2nd, When the opposite condition exists, that is, when the membrane is almost totally destroyed, the red and swollen mucous membrane of the inner wall of the tympanum may be confounded with an inflamed tympanic membrane: 3rd, In cases of moderate-sized perforations where the edges of the perforation are in contact with or adhering to the inner wall of the tympanum: 4th, When the membrane, either in whole or in part, is so transparent owing to its having become atrophied or become converted into cicatricial tissue, while it lies so close to the inner wall of the tympanum, that the parts inside the tympanum opposite the membrane are seen as if no membrane existed (Fig. 75). If the transparency is limited to a part of the membrane, it is particularly apt to be mistaken for a perforation. If secretion exists in the tympanum opposite the atrophied part, the appearance may be strikingly like that of secretion seen through a perforation.

In any of these conditions inflation of the middle ear, by Politzer's method or Valsalva's experiment, is the most important aid to diagnosis. If the perforation is small, a hissing or whistling sound is heard during inflation, usually so distinct as to be heard even by a bystander; or, if auscultation is employed, it may be so loud as to be painful to the ear of the surgeon. By inspecting the interior of the ear during inflation, if there be secretion in the tympanic cavity, we are usually able to see secretion mixed with bubbles of air projected from the orifice in the membrane. When there is only a small perforation, while the pus contained in the tympanic cavity is very thick, we may find on inspecting the interior of the ear during the attempt to inflate by Valsalva's method, that only a drop of thick pus appears at the orifice, without the passage of air, and, when the effort to inflate has ceased, the drop of pus recedes again into the tympanic cavity. If we find, after inflation, air bubbles in the inner end of the canal, which were not there before inflation, we may assume the existence of a perforation; or if, after removing all secretion and then inflating, we find secretion in the inner end of the canal, we may be assured that there is a gap in the membrane. When there is almost complete loss of the membrane, and when the mucous lining of the tympanum and Eustachian tube is swollen and partially covered with secretion, we can usually also make out by auscultation, during inflation, the loud hissing or whistling sound. When, however, there is neither swelling nor secretion, the sound is an exaggeration of the normal auscultation sound, being full and blowing, and giving the impression of being produced in the auscultator's ear. In these cases of almost complete destruction we usually see, after syringing and careful drying, the narrow rim of membrane at the margin, especially in the situation of the membrana flaccida. If this is not seen, we may observe a cleft or fissure just at the inner end of the canal of the ear in the situation of the annulus tympanicus. When the difficulty in diagnosis is due to the edge of the perforation being in contact with or adhering to the ossicles or the inner wall of the tympanum, examination of the membrane during inflation of the middle ear, or during suction by the pneumatic speculum, will usually aid materially in the diagnosis of the case. In like manner the actual condition present in transparency of the membrane from atrophy or cicatrization, is at once shown by the bulging outwards of the thinned membrane during inflation or suction (Fig. 76). If the perforation consists of a simple fissure in the membrane, the separation and moving outwards of the edges of the fissure during inflation will ensure its recognition. It is to be remembered, however, that we sometimes cannot inflate the middle ear, in consequence of great obstruction in the Eustachian tube from swelling of its mucous membrane, adhesions, &c. Or there may be adhesions in the tympanic cavity, which prevent the current of air reaching the perforation. On the other hand, if the Eustachian tube is freely open, we may find persons able, by Valsalva's experiment, to expel a current of air of strength sufficient to affect a light held opposite the ear; and, if a manometer be fixed in the canal of the ear, the fluid in the manometer is forced completely out of the tube. We sometimes meet with individuals, who can force tobacco smoke from the throat out of the ear. We occasionally get information of the existence of a perforation, while syringing the ear before examination, by the remark of the patient that he feels the injected liquid in his nose or throat, and we may in such cases even see the fluid escaping from the nostrils.

We have lastly to mention that a pulsating movement is frequently observed in secretion or other fluid lying over the membrane. This in the great majority of cases denotes a perforation. The movement is due to pulsation in the small arterioles of the inflamed mucous membrane of the tympanic cavity causing a rhythmical rising or falling, or sometimes a lateral movement, of the secretion in contact with it. The pulsation is generally most marked when the perforation is small, and it is also most distinct in spots where there is a special reflection of light. It is to be remembered, however, that pulsating movements are occasionally seen, when the membrane is certainly intact.

Prognosis.—In viewing the prospects of a patient, who suffers from this disease, we must take into account the possible consequences and complications, both to the structures within the ear and the organs outside of it, which may attend this affection. Such a consideration will impress us with the truth of Wilde's oft-quoted saying that, "when a discharge from the ear exists, we can never tell how, when, or where it will end, or to what it may lead."

In estimating the prognosis we must consider—1. The amount of damage inflicted upon the structures of the ear. If there is almost complete destruction of the tympanic membrane, a permanent perforation may be anticipated. This always exposes the tympanic cavity to injurious influences from without, and thus tends to encourage the recurrence of the purulent inflammatory process. When there is a small perforation, on the other hand, there may be considerable difficulty in curing the disease; but, when it is cured, there is much less tendency to recurrence. If polypi or great thickening of the mucous membrane exist, the purulent process will continue until the removal of these conditions, when a permanent cessation of the discharge is usually attained. The formation of adhesions or false membranes in the tympanum, or of stricture of the Eustachian tube or external auditory canal, are unfavourable circumstances, owing to the hindrances which they present to the escape or removal of the purulent secretion, or to the application of healing agents. Carious disease of the bone is of very serious import, not only by frequently rendering the discharge incurable, but, also, if affecting the partitions between the middle ear and the interior of the cranium, or the canals for the large blood-vessels, by exposing the patient to the danger of a fatal issue. Necrosis is not so formidable a complication, for, by the removal of the sequestrum, the cure of the discharge is generally achieved.

2. The source and character of the discharge are important considerations. If the source of the secretion is in the upper tympanic cavity, antrum mastoideum, or other mastoid cells, especially with only a small perforation in the membrana flaccida, the difficulty of curing the discharge and the danger of serious complications are much greater. On account of the anatomical formation of the parts, the complete removal of the secretion is extremely difficult, and stagnation, accumulation, and decomposition of the purulent products, form a constant menace to the life of the patient from septic absorption or extension to the interior of the cranium. Disease of the bone and injury to the facial nerve in the Fallopian canal are also more likely to be produced by the disease, when chiefly confined to these localities. The character of the secretion may throw light upon the prognosis. An offensive odour, which is strong and persistent in spite of frequent and thorough cleansing, raises the suspicion of diseased bone; if, besides, it is usually sanious without granulations or polypi in the ear, this suspicion approaches well nigh to a certainty. When the discharge is composed chiefly of copious, stringy mucus (blennorrhœal discharge), with a pretty large perforation (frequently seen in children), the case is generally extremely obstinate and persistent.

3. The state of the hearing-function may supply useful information. If the hearing is not very defective, and if improved considerably by cleansing and inflation, the obstacles to the conduction of sound are probably remediable. If there is great deafness, with severe subjective sounds

not relieved by inflation, and if there is also defective perception of sound by osseous conduction, there is small prospect of improvement in hearing, although the secreting process may be put an end to; either the fenestral structures or parts of the labyrinth are involved.

4. The cause of the disease, its duration, and the results of treatment must be taken into account. When it originates in diphtheria, scarlet fever, or tubercular disease, or when associated with a strong hereditary tendency to ear disease, it is often specially obstinate. In most cases, the longer the disease has existed the more difficult is its successful treatment. The failure of long-continued judicious treatment must also be looked upon as an unfavourable omen.

5. The constitution of the patient as well as his avocation, habits, and position in life must influence our prognosis. The strumous, tubercular, and syphilitic constitutions must be regarded as highly unfavourable to rapid or complete recovery. In the strumous patient diseased bone and glandular enlargements or suppurations are more frequent complications; in the tubercular, rapid but painless softening and destruction of the membrane and intractability to local treatment are marked features; while in syphilis labyrinthine complication is not unfrequent. The disease is also particularly obstinate in persons, who are frequently exposed to inclement weather with insufficient protection, or in ill-fed and ill-tended children.

A very important question may be asked, *What proportion of patients, who suffer from chronic suppurative disease of the middle ear, have their lives cut short thereby?* This is a question, regarding which our information is still meagre. With the increased interest in diseases of the ear taken both by the public and the profession, and especially as the result of fuller and more correct knowledge of the serious consequences which may attend them, we may soon be in a position to give at least an approximate answer to this question. Von Tröltsch and others assert, as the result of their observation of large numbers of aural patients, that sufferers from otorrhœa have not the average duration of life, and that they frequently fall victims at a comparatively early age, either to the direct consequences of the disease, or to phthisis or other wasting disease. It is, at all events, noteworthy that, while this disease comes extremely frequently under our notice in children and persons before middle life, we meet with it comparatively rarely after middle age, either in the actually secreting form or in the stage of "the dry perforation" with impaired function of the organ, a condition in which, considering the great frequency of the secreting stage of the disease in early life, we would expect to find very many aural patients who have passed middle life.

This leads us to the consideration of a question, which has been discussed of late years, namely, whether a person, who suffers from chronic discharge from the ear, should be accepted by an insurance company. Von Tröltsch is of opinion that its signification in relation to life assurance is as serious as many cases of valvular heart disease, tubercular disease of the lung, or hernia. Without attributing to this disease any such importance as organic heart disease or pronounced phthisis, the writer thinks its existence in an applicant for life assurance should be taken into account in calculating the probable duration of life, and that forms of proposals issued to intending insurers should contain the question, "Is there or has there been any long-continued discharge of matter from the ear?" The unfavourable points requiring consideration in deciding upon the degree of gravity of any particular case have been referred to under the head of prognosis. The effects of treatment are probably of greatest importance in deciding the suitability for life assurance. If treatment has been attended by complete cicatrization of the perforation, the life may be accepted without reservation. If, however, a dry perforation has been left behind, although the purulent process has been cured, the risk of recurrence of the disease should be met by some addition to the annual premium. On the other hand, if rational and long-continued treatment has failed in putting an end to the purulent process, acceptance should be postponed or a considerable addition made to the premium.

Are sufferers from chronic discharge from the ear fit for military service? When we consider the tendency in this disease to acute inflammatory attacks, which would incapacitate a soldier for duty, the fluctuating condition of the hearing, and the possibly serious consequences to life itself, the writer thinks it would be proper in the interests both of the individual and of military efficiency to exclude persons suffering from this disease from such a life of exposure as that of a soldier in the field.

Treatment.—In chronic suppurative inflammation of the middle ear *local* treatment is by far the most important. We must not regard the closure of the perforation in the membrane as the main object. In many cases it may rather be looked upon as a fistulous orifice, which it is desirable to keep open, until the real seat of the disease—the mucous membrane of the middle ear—has been effectively treated. Probably the chief difficulty in the way of successful treatment is due to the peculiarly complicated anatomical structure of the spaces forming the middle ear, rendering, in many cases, the thorough removal of the secretion a very difficult task.

Cleansing and Disinfection.—In order to obtain success it is essential to remove the inflammatory secretions, and cleanse and disinfect the interior of the ear, so far as possible.

Cleansing measures may be applied either through the external auditory canal, or through the Eustachian tube. By the former channel we may employ ordinary syringing (see p. 105), intra-tympanic syringing (see p. 108), or simple drying. Ordinary syringing by the external auditory canal is always necessary, if the discharge is profuse. It should be done twice a day, or, if the discharge is very copious, as frequently as four times. This method is usually sufficient, if the perforation is large, and if there is no collection of secretion in the upper tympanic cavity or mastoid cells. If, however, the perforation in the membrane is very small, or if there are accumulated masses in the parts just referred to, other methods are required, such as the use of the intra-tympanic syringe. Epithelial masses are sometimes found filling the inner end of the canal of the ear, adhering tenaciously to its walls, and long-continued ordinary syringing may not be sufficient to dislodge and remove such masses, until a preliminary process of soaking, similar to the softening of cerumen, has been carried out. Cautious dislodgement with the probe may be necessary before syringing becomes effective. The introduction of the tube of the intra-tympanic syringe (Fig. 96) as far as these masses, and injecting fluid directly into them, may be required to ensure their separation and removal. In cases where purulent, caseous, or epithelial masses have been for a length of time stored up in the upper tympanic cavity or antrum mastoideum, and where the syringe has rarely or never been employed, severe pain in the ear may be excited, after a few applications of the syringe, from the swelling of the masses owing to their absorption of the injected fluid. The pressure thus

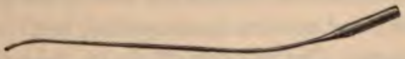

FIG. 96.—Tube of the intra-tympanic syringe.

exerted upon the walls of the middle ear may, in some cases, even excite an acute attack of inflammation. If we suspect the presence of such accumulations, it is well to forewarn the patient of the possibility of pain being temporarily produced by the treatment, explaining to him the cause of it. Masses of offensively smelling material usually come away after the syringing has been continued for a few days, with relief to the patient and improvement in his condition.

Dry cleansing, by means of absorbent cotton on a cotton-holder, is to be preferred to syringing, if the latter constantly produces disagreeable symptoms, or if the secretion is small in quantity, and not offensive to smell. *In any case, after fluid injections, the moisture in the ear must be thoroughly mopped up, and the parts dried with absorbent cotton.*

Suction by means of Siegle's pneumatic speculum, fitted air-tight into the external auditory canal, is sometimes useful in drawing out the secretion from the middle ear, especially when the perforation is small, or the source of the discharge is in the upper tympanic cavity and antrum mastoideum. Suction is at the same time useful in separating adhesions or preventing their formation. The pus, which exudes from the perforation during suction, is to be wiped away, and suction again applied, until secretion no longer appears. The inflation of air by the intra-tympanic tube introduced through a perforation and directed towards the antrum mastoideum is, in some cases, of use in forcing the secretion outwards and through the perforation. These two last-mentioned methods, namely, suction and inflation of air through the perforation, are of special service, when the Eustachian tube is impermeable.

Injections through the Eustachian tube (see p. 110) produce a very beneficial effect in certain persistent forms of purulent disease which have resisted other modes of treatment, and should be employed in any case which is particularly obstinate.

Solutions, suitable for *cleansing and disinfecting* the middle ear, will be found under f. Nos. 50 to 58. A selection may be made from the following:—1. A weak solution of common salt or bicarbonate of soda, or a four per cent. solution of Glauber's salt. 2. Solution of boracic acid (as much as will lie upon the end of a penknife dissolved in eight ounces of water). 3. A two per cent. solution of carbolic acid in water. 4. A five per cent. watery solution of permanganate of potash. 5. Solution of salicylate and bicarbonate of soda (f. 57). 6. When the discharge consists in great part of stringy mucus (Blennorrhœa) four or five drops of oil of turpentine added to eight ounces of water (Politzer) form a suitable cleansing liquid. For cleansing by the Eustachian tube, the 1st and 2nd solutions are alone suitable. These solutions must all be used *warm*.

The efficiency of these cleansing measures is much aided by inflation of the middle ear, especially by Politzer's method, which is of great value in forcing out secretion from the middle ear to the external auditory canal, more particularly when the perforation is small. After syringing and drying the ear, effective inflation will be often found to be followed by the appearance of more secretion, mixed with bubbles of air in the inner end of the external auditory canal. Inflation usually also improves the hearing, for the time at least, by blowing away secretion, by pushing out the remnant of membrane and the ossicular chain, and by separating loose adhesions. The success of these cleansing operations is often frustrated by the extreme smallness of the aperture in the membrane, which hinders the complete expulsion of secretion, or the admission of the cleansing fluid. In such a case enlargement of the perforation by the paracentesis knife has frequently an excellent effect upon the course of the disease. When there is a bulging, as if from accumulated secretion, in a part of the membrane distant from the existing perforation, a second aperture made into the bulging part may aid very much in successful treatment.

Use of Medicated Agents.—In a certain proportion of cases simple cleansing and disinfection, carried out in a thorough and effective manner, is sufficient to remove the disease and heal the perforation. In most cases, however, it is necessary in addition to act upon the diseased mucous membrane of the middle ear with various kinds of medicated agents. The first in value is undoubtedly the *group of antiseptics*, and especially *boracic acid*. In boracic acid, employed as a fine powder, we have probably one of the most valuable remedial agents, which have been put into the hands of the aural surgeon in recent years. As a remedy for purulent disease of the middle ear, this substance was first introduced to the profession by Dr. Friedrich Bezold of Munich in a paper entitled "Zur antiseptischen Behandlung der Mittelohreiterungen," which appeared in the *Archiv für Ohrenheilkunde* of 13th June, 1879. While it was at first employed by Bezold on purely antiseptic principles, he does not maintain that its beneficial effects in chronic purulent disease of the middle ear are due solely to its antiseptic properties. Indeed, the anatomical peculiarities of the middle ear do not admit of Lister's antiseptic method being carried out. Considering that in the form of solution the use of boracic acid is not at all so satisfactory as in the form of powder, it is probable that a not inconsiderable part of the good effect is due to its being a very fine, non-irritating powder. It is now admitted by all that a constantly moist condition of the interior of the ear, as from the presence of astringent solutions, is very unfavourable to recovery from the purulent process, and that a fine bland powder by absorbing moisture and so keeping the parts dry is, apart from any antiseptic property, a beneficial application. Boracic acid has the great advantage over such a powder as alum that it does not form with the secretion hard masses, which are difficult to remove, but, on the contrary, it is immediately and easily removed by syringing with warm water. The powder should be extremely fine, and should be blown into the ear by means of a tube (Fig. 29). A portion of a quill or a glass tube forms a cheap and convenient instrument. A small quantity of the powder is placed in the tube, and blown into the external auditory canal. A piece of India-rubber tubing attached to one end of the quill will enable the patient to insufflate the powder into his own ear. In order to increase the antiseptic effect of the powder, Politzer adds, in some cases with a peculiarly strong fœtiddis charge, one grain of carbolic acid to fifteen grains of boracic acid, while in the blennorrhœal forms he adds three to four drops of oil of turpentine to fifteen grains of the boracic acid.

The boracic acid treatment is usually employed in the following manner:—1. The purulent secretion is removed by syringing with a warm aqueous solution of boracic acid (four per cent.), or a two per cent. solution of carbolic acid. If that is insufficient for thorough cleansing, one or other of the methods already described of washing out the middle ear must be employed. 2. The moisture in the interior of the ear is then thoroughly removed, and the parts dried by means of absorbent cotton. 3. The middle ear is next inflated by Politzer's method, and, if more secretion is thereby forced out of the perforation, drying with absorbent cotton is again employed. 4. The fine powder is then insufflated into the canal of the ear so as to fill the inner half of the canal, while the outer half is to be occupied by a plug of salicylic or carbolized cotton.

In some cases, especially when the secretion is small in quantity, and blennorrhœal in character, or when syringing produces disturbing symptoms, it is better to avoid the syringing altogether, simply wiping away the moisture with cotton, and insufflating the powder, or applying to the parts a pellet of dry cotton covered with boracic acid.

When the treatment is intrusted to the patient at home, thorough instructions should be given previously by the surgeon, who should make sure that the patient is able to blow the powder into the inner end of the canal. If too wide a tube is employed in the case of a child or of a person with a narrow external auditory canal, the powder is very likely to reach no further than the *outer* part of the canal of the ear. Firm packing of the ear with the powder is to be avoided, especially if the perforation is small. A case has come under the writer's notice in which severe pain, giddiness, and fainting were excited by packing the ear very firmly with the powder.

After the powder has been employed in the manner just described, the ear should not be disturbed until the powder has become soft or moist, when the same process of syringing, drying, inflating, and insufflating has to be repeated. In some cases of profuse discharge the application may have to be repeated twice a day, in others once a day. When this mode of treatment answers well, the powder will soon be found to remain dry for two or three days, and by and by for weeks. When it is finally syringed out, the interior of the ear must be well dried. In a few cases, three or four applications of this treatment are sufficient to put an end permanently to the secreting process; in some cases, however, continuance of treatment for two or three months is needed before permanent cessation of the secreting process has been achieved. If granulations or polypi exist, these must necessarily be dealt with before the boracic acid treatment will prove effectual. The cases of purulent disease of the ear which are least benefited by this treatment are, 1st, those in which the perforation is pin-point in size; 2nd, those in which caries or necrosis exists; 3rd, those where the seat of the secretion is in the upper tympanic cavity, antrum mastoideum, or other mastoid cells; 4th, those associated with phthisis or very pronounced scrofula.

In certain cases, especially those characterized by a persistently offensive smell, Politzer employs a spirituous solution of *Carbolic Acid* (f. 39). This mode of treatment is very apt to be irritating, and is much inferior to the boracic acid treatment. *Iodoform*, in the form of powder or solution, is frequently employed. The writer has found its use most valuable along with rectified spirit (f. 40). Only a portion of the iodoform is dissolved by the spirit, the rest remains in suspension. After thorough shaking of the mixture, so that the undissolved part may be intimately mixed with the fluid, about fifteen drops are poured into the ear, and allowed to remain there for fifteen minutes, after which the ear is dried. A portion of the undissolved powder remains in contact with the diseased surface. The writer has found a few applications of this remedy successful in bringing about a cure, after all other remedies had been employed ineffectually for a whole year. This treatment is peculiarly suited for cases of perforation of the membrana flaccida, or where the source of the discharge is in the upper tympanic cavity or antrum mastoideum. The most efficacious way of applying it in these circumstances is by the intra-tympanic tube, after thorough cleansing. If this method is not adopted, the next best is to pour the fluid into the ear, and, while the head is held back, the tragus is frequently pressed firmly inwards towards the external auditory canal, so as to force the fluid through the perforation into the actual seat of the source of the discharge.

Salicylic acid is sometimes used, both in the form of solution and of powder. The author has occasionally found the addition of this acid to powdered boracic acid (one of the former to four of the latter) to add, apparently to the efficacy of the application. In obstinate cases, when other antiseptics prove ineffectual, a spirituous solution of salicylic acid, beginning with a strength of 2 per cent. and going on to 10 per cent., may prove successful. Its irritating effect, especially when used in the larger proportions, is a disadvantage.

The caustic treatment is probably second in importance to the antiseptic, and is often conjoined with the latter. When, for example, small granulations are found in the diseased mucous membrane, or on the edge of the perforation, preliminary treatment by the application of the solid nitrate of silver, strong solution of perchloride of iron, chromic acid, or the galvanic cautery, is essential to the success of the boracic acid or other antiseptic mode of treatment. The methods of applying these various caustics to granulations will be described under the treatment of polypi.

A strong solution of nitrate of silver, as recommended by Schwartze, is an excellent remedy. It is particularly indicated, when there is a pretty large gap in the tympanic membrane, with considerable swelling of the mucous membrane and profuse muco-purulent discharge. There is rarely more than slight pain or warmth produced in the ear, even when acute inflammation is present. Some writers assert that it even relieves pain in such cases. Preliminary cleansing and drying are here desirable. The more thoroughly the mucous membrane intended to be treated is freed from all moisture, the better will be the therapeutic effect of the nitrate of silver. The strength of the solution should be from 20 grains to 60 grains in an ounce of water.

Ten drops of the warmed solution are injected into the ear by means of Pravaz' syringe (Fig. 97), or dropped in from a glass pipette, while the patient's head is held to the side. After remaining in the ear for five minutes, during which a cotton plug soaked in a solution of salt should lie in the orifice of the ear, the ear should be syringed with a warm and weak solution of common salt, so as to neutralize the nitrate of silver, and wash away the caustic solution. If much pain is excited, which is rare, the saline solution may be used immediately. In order to prevent blackening of the skin of the ear or its neighbourhood by the nitrate of silver, these parts should be wiped with a solution of common salt or of iodide of potassium.

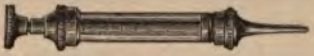

FIG. 97.—Pravaz' Syringe.

The solution of caustic produces a white layer, which is afterwards thrown off, exposing again the red mucous membrane. A fresh application of the solution should not be made, until this white layer has been thrown off, which may take one or two days. If no distinct benefit is observed after six or eight applications, the solution must give way to some other remedy. Politzer speaks highly of the beneficial effects in obstinate cases obtained from a course of alum treatment (see further on) following this caustic method. The writer has found boracic acid, although ineffectual at first, become completely efficacious after a few applications of caustic. The solution of nitrate of silver may also be applied with advantage to the diseased parts, which are exposed to view, by means of cotton on a cotton holder.

The treatment by *rectified spirits*, introduced by Löwenberg and Weber-Liel, is undoubtedly very valuable. It is most strikingly useful in cases associated with small granulations. It probably acts by virtue of its power of absorb-ing water, and thus removing the serous infiltration. After its application the mucous membrane, previously red and swollen, is seen to be paler. After preliminary cleansing and drying, 15 or 20 drops of the warm spirit are poured into the ear, while the patient lies on his side, and allowed to remain in the ear for fully 20 minutes, after which the inside of the ear is dried, and a plug of cotton inserted. This should be repeated three times a day. It is well, during the first two or three days, to dilute the spirit with an equal quantity of water, till we ascertain how it is borne by the patient. In some cases only the diluted form can be borne in consequence of the pain produced by the spirit in full strength. This mode of treatment may be continued for several months, and possesses the advantage, which does not belong to caustic, of being capable of employment by the patient at home.

The treatment by *astringents* is the next method, which we have to consider. Until recent years these and caustic were the trusted means employed by aural surgeons. They are now much less frequently adopted, being in great measure supplanted by boracic acid and alcohol. There are still cases, however, in which the latter prove ineffectual, while astringents are successful. Astringents should never be employed during an acute exacerbation, as they will then irritate, and increase the pain and inflammation. They are used in the form either of solutions or of powders. Solutions are applied in the following ways—1st, If the perforation is large, fifteen drops of the warm solution are simply poured into the ear, while the head is held to the side, and allowed to remain there for ten minutes. This is repeated twice a day, or oftener if the discharge is very copious, being preceded on each occasion by thorough cleansing and drying. After the solution is allowed to run out, the parts inside the ear are dried, and a plug of antiseptic cotton introduced into the canal. 2nd, If the aperture in the membrane be small, there are two methods by which the fluid, lying in the external auditory canal, may be helped into the middle ear. By inflating the ear, especially by Politzer's or Valsalva's method, air is forced through the perforation and through the fluid, giving rise to bubbles which are seen on the surface of the fluid. Immediately afterwards the fluid subsides, and a portion passes through the perforation into the middle ear. The performance of Toynbee's experiment is also sometimes attended by the passage of some of the fluid into the middle ear. Another simple method is to press the tragus frequently and firmly inwards upon the fluid in the external auditory canal. When any of these methods is successful in causing fluid to pass through the perforation into the middle ear, the patient may, if the Eustachian tube is permeable, feel the fluid in his nose or throat. One of the best and most useful astringents is sulphate of zinc; the addition of carbolic acid probably adds to its usefulness (f. 35). Sulphate of copper (f. 36) or acetate of lead (f. 32) is also useful, and may be alternated with sulphate of zinc. A solution of alum is beneficial, but has the disadvantage of frequently exciting boils in the canal of the ear. While acetate of lead and perchloride of iron are very effective, they tend to form depositions on inflamed or abraded surfaces, which are difficult to remove, and which may afterwards impair the vibrating power of the tympanic structures. *Finely powdered alum* is the most efficacious astringent, but, for the reasons about to be stated, it can only be applied by the surgeon himself. It is most suitable, when granulation tissue exists, and when a considerable portion of the membrane is destroyed. Politzer recommends a course of the powdered alum insufflations to be carried out after a course of nitrate of silver. There are two disadvantages attending the use of alum—1st, It forms a hard mixture of pus and alum, which adheres firmly to the parts, and generally requires to be dislodged and broken up by a probe, before the syringe and warm water can wash it away. This difficulty forbids its use in young children or very sensitive adults. 2nd, It also tends, unless very carefully applied, to irritate the skin of the external auditory canal, and may even excite inflammation, which may pass in and aggravate the deeper disease. In order to avoid or lessen this effect only a small quantity of the powder should be insufflated, and we should carefully wipe away any which may lie on the skin of the external auditory canal. The mode of insufflating the alum is the same as that for boracic acid. The writer sometimes applies it to the diseased part by means of cotton on a cotton holder. The frequency of repetition of the insufflation will depend upon the length of time, during which the powder remains dry. So long as it is dry, it should remain undisturbed. When it is found moist, the mass should be carefully separated and washed away, the parts carefully dried, and a fresh insufflation made. If this mode of treatment proves ineffective after eight or nine applications, it should be abandoned.

Of these various local applications for chronic suppurative disease of the middle ear, we cannot, in a given case, predict with certainty which will prove most successful. The size of the perforation, the presence or absence of granulations, the actual source of the secretion, have all to be taken into account in the selection of the remedy. The boracic acid treatment is the most generally successful, and we should therefore, in most cases, begin with this. But one remedy after another has sometimes to be tried, until we come upon the right one, and what is found to be an ineffective remedy at one stage of the disease may be very successful at another stage of the same case. The boracic acid, the alcohol, and the fluid astringents may be continued for a great length of time, after the patient thoroughly understands how to apply them. The caustic and alum treatment, on the other hand, as well as that by intra-tympanic injections, can be employed only by the surgeon, and the two former only for a limited time, as already mentioned. When we entrust the carrying out of the treatment to the patient or his friends, it is desirable to see the case at least every two or three weeks in order to judge whether a change or modification of treatment may not be required. In view of the possible consequences of the disease, the patient should be urged to continue the treatment, even for many months if necessary, so as, if possible, to put an end to the purulent process. *In a large majority of cases* this will be achieved by perseverance and by a proper selection and variation of remedies. It is to be noted that, even some time after apparent recovery, the surgeon should examine the ear to make sure that the recovery is real, as patients are very ready to think that the disease is cured if no matter appears externally, while there may really still be some secretion going on. Besides, crusts or desquamative collections may form, after the discharge has ceased, and these require to be removed.

In cases, where a permanent perforation is left behind, a plug of wadding should be kept in the canal of the ear during windy wet weather. Water should be carefully excluded from the ear, and nasal colds avoided if possible.

The cure of the suppurative process is generally attended by improvement, sometimes very considerable, in the hearing-power. Where the hearing still remains defective, after the active secreting process has ceased, there are certain modes of treatment, designed to improve the hearing, which should be tried. These are—1. inflation of the middle ear and rarefaction of the air in the external auditory canal; 2. certain operative measures; and, 3. the use of the so-called artificial tympanic membrane or "drum."

1. Inflation of the middle ear and rarefaction of the air in the external auditory canal may prove useful by separating soft adhesions and improving the tension of the ossicular chain. When a dry perforation exists, inflation should be performed, while the canal of the ear is plugged up, in order to augment the effect of the air pressure. These methods are more likely to be successful, when employed immediately after the cessation of the suppurative process; but they should not be continued too long. (See precautions in regard to duration of treatment by inflation at p. 321.)

2. When the defect of hearing is very great, and when no improvement is effected by other methods, incision of the adhering or thickened tissue may be followed by benefit. A certain degree of mobility, as tested by suction, must exist before such measures are employed, and no attempt of this kind should be made, unless the state of the osseous conduction of sound shows that the nervous apparatus of hearing is good. Attempts are sometimes made to secure cicatricial closure of old dry perforations by cauterizing the edges with solid nitrate of silver. Such attempts may excite a return of the purulent disease, and lead to further injury to the organ, while efforts of this kind rarely or never succeed in closing the perforation. Complete closure of the perforation, it is to be remembered, may be attended by increase in the deafness. Hence cicatrices are sometimes opened up again by cutting or with the galvanic cautery, with the intention of improving the hearing power; but this is usually unsatisfactory, as fresh cicatricial tissue forms, with, it may be, an aggravation of the deafness. Repeated incisions into a cicatrix occasionally prove useful, just as we found in the case of atrophied parts of the membrane. In the various forms of adhesions between the tympanic membrane and the inner wall of the tympanum, or between the membrane and the incus and stapes, attempts with sharp instruments to separate the ad-

hering parts are unsafe and ineffective ; but, as Politzer has suggested, incisions made through the membrane close to the adhesions, followed by inflation, are not unfrequently advantageous to the hearing. When, for example, the membrane is adherent to the promontory, simple incision around the adherent part may prove beneficial; and, when it is adherent to the articulation of the incus with the stapes, a horizontal incision below the adhesion, by lessening the tension, may improve the hearing. When bands connect and bind the handle of the malleus to the inner wall of the tympanum or to the long process of the incus, their division with the knife may help to set free the ossicular chain. When, however, the manubrium is bound to the inner wall of the tympanum by direct adhesion, we must not endeavour to separate them by insinuating a knife between, but content ourselves with repeated incisions in the membrane, in the neighbourhood of the manubrium. Incision into the tense posterior fold of the membrane may help to set free the indrawn manubrium. So, also, a perpendicular incision behind the manubrium into a thickened and stiff membrane may relieve the tightness and improve the hearing. When the recess leading into the fenestra ovalis is exposed to view, and the stapes appears to be unduly drawn backwards and inwards by a shortening of the tendon of the stapedius, the division of this tendon has been recommended, and when cicatricially shortened such a division may be useful. The propriety of these operative measures, which are sometimes carried out with the object of improving the hearing after chronic suppurative disease of the middle ear has run its course or has been cured by treatment, can only be judged of, and the manipulations should only be undertaken, by an experienced aural surgeon.

3. The method of improving the hearing after a chronic suppurative process has come to an end, or even before it

has totally ceased, by the use of the *artificial tympanic membrane*, has been fully described in the chapter on methods of treatment (see page 132).

External applications, such as vesicants or stimulants, are frequently used behind the ear by practitioners. These applications are sometimes injurious, and, in the absence of proper treatment to the interior of the ear, quite useless. The writer never applies vesicants in the treatment of this disease, and he is not aware that they are now recommended by any aural surgeon. The practice of using them without any attention to the seat of the suppuration, without even any attempt to clean away the decomposing pus which fills the ear, is utterly bad. Only in syphilitic or markedly scrofulous persons are applications of iodine preparations behind the ear likely to do any good, and always merely as auxiliary to the careful treatment of the interior of the ear.

The nasal and pharyngeal mucous membrane must, in all cases, be examined, and, if any morbid condition be found to exist, such as adenoid vegetations or chronic catarrh, it must be properly treated. (See Chapter III, Part I.)

General constitutional treatment is required, especially when the disease occurs in persons of a scrofulous, anæmic, syphilitic, or tubercular constitution (f. Nos. 91 to 107). The student is referred to "hygienic treatment," page 147.

CHAPTER III.

CONSEQUENCES OF CHRONIC SUPPURATIVE INFLAMMATION OF THE MIDDLE EAR.

A. CONSEQUENCES LIMITED TO THE EAR ITSELF.

1. Aural Polypi.

WITH extremely few exceptions, polypus of the ear is the result of an antecedent purulent process in that part of the ear, from which the growth springs. And as, in the great majority of cases, these growths spring from the mucous membrane of the middle ear, and are the results of chronic suppurative inflammation of the middle ear, it is convenient to describe them under the heading of the consequences of that disease.

Pathology.—Three forms of polypus are met with in the ear. These have been named by Steudener, from their histological characters, 1. Mucous Polypi; 2. Fibrous Polypi; and, 3. Gelatinous Polypi or Myxomata. The mucous variety is by far the most frequent, the gelatinous is extremely rare.

1. *Mucous Polypi.*—These are red, soft, globular, or, if large, club-shaped masses, which are apt to bleed, from even gentle touching. Their surfaces are frequently beset with small, red granular projections, resembling the surface of a raspberry. When they are so large as to fill the tympanum and the whole of the external auditory canal, the surfaces,

which press upon the surrounding walls of the external auditory canal, are usually rendered smooth. Their attachment to the mucous membrane is frequently pedunculated, but they are also found, not uncommonly, to have a broad or sessile base. Sometimes the stem divides into two branches, each supporting a polypus, or one polypus may have two or more pedicles. Probably in as many as nine out of every ten cases aural polypi have their roots in some part of the mucous lining of the tympanic cavity, and the growth is seen through the perforation in the tympanic membrane, or, if large enough, it extends into the canal of the ear, even so far as to project at its orifice (Fig. 101). They spring most frequently from the posterior or inner wall of the tympanum, but also frequently from the inner surface of the membrane near the edge of a perforation. The growths are often associated with a very thickened condition of the mucous membrane of the tympanic cavity, called by Wendt polypoid hypertrophy of the mucous membrane. They are occasionally attached to some part of the ossicular chain. They more rarely grow from the tympanic opening of the Eustachian tube, and they have in some cases their origin in the mastoid cells, from which they may project into the back of the tympanic cavity, or protrude through a carious opening in the posterior osseous wall of the external auditory canal. In comparatively rare cases they grow from the outer surface of the tympanic membrane, and cases occur in which they seem to consist of the tissue of the membrane itself—polypoid degeneration of the membrane. They are found least frequently to have their base in the external auditory canal, when they are usually the consequence of otitis externa acute or chronic, and are found in the osseous part of the canal.

The size of mucous polypi presents great varieties, from that of a hempseed or pin-head, so small as to be scarcely distinguishable in the secretions of the tympanum, to one, which fills the tympanum and external auditory canal, projecting, fungus-like, from the external opening of the ear (Fig. 98).

Structure of Polypi. — Mucous polypi (Figs. 99 and 100) are hyperplastic growths of mucous membrane, and consist, microscopically, of numerous round cells, connective-tissue fibres, glands, cystic spaces, and blood-vessels. The surface has often a papillary structure, or contains many gland-like depressions, and stratified epithelium covers it. On the deeper part of the growth, near the root, the epithelium is sometimes columnar and ciliated. When the polypus protrudes from the outer orifice of the ear, the part which projects ex-

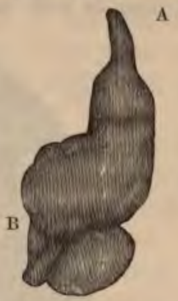

FIG. 98.—Large mucous polypus, which dilated the external auditory canal and protruded from the orifice of the ear—A, pedicle; B, head.

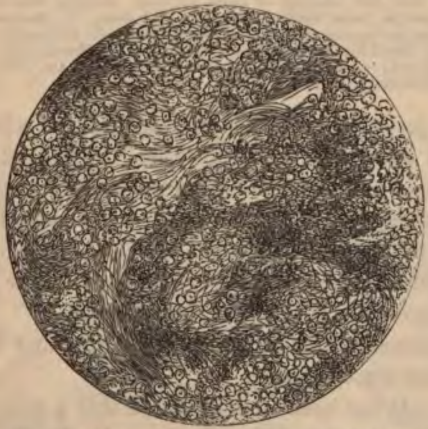

FIG. 99.—Section of aural polypus. Central portion (300 diam.). Mucous areolar tissue, containing granular cells and nuclei of cells. (Drawn by Dr. John Wilson.)

ternally is sometimes covered by a fine cutis. Several polypi may exist in one ear, while it is not uncommon to find them in both ears.

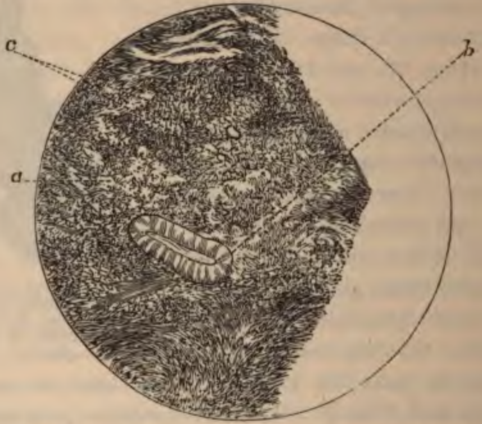

FIG. 100.—Section of aural polypus. General view of portion near surface (40 diam.), showing—*a*. Mucous areolar basement tissue, with granular cells and nuclei; *b*, Gland-like follicle, lined by epithelium, chiefly cylindrical; *c*, Small blood-vessels. (Drawn by Dr. John Wilson.)

Fibrous polypi are much less frequently met with. They are much paler and smoother than the mucous variety. They contain no cysts and comparatively few vessels. The tissue consists of a pretty dense fibrous stroma with spindle cells, and they are covered with stratified epithelium. The true fibrous polypus seems generally to arise from the periosteum of the canal or of the tympanum.

The *myxomatous variety* is extremely rare, and consists of a gelatinous mucous tissue.

Causes.—It has been already stated that a polypus in the ear is, in the great majority of cases, the result of chronic suppurative inflammation of the middle ear. The irritating effects produced by the constant saturation of the parts with pus undoubtedly contribute very materially to their formation. The growths on the other hand aggravate the discharge by maintaining the chronic inflammation of the middle ear—the original disease. It is probable that persons of scrofulous constitution, who suffer from suppurative disease of the ear, have greater liability to the formation of polypi.

While polypi are generally secondary to a purulent process, there are authentic cases, though rare, of the polypus being the primary disease, giving rise secondarily to inflammation, suppuration, and perforation of the membrane.

Polypi are found more frequently in males than in females, and more frequently in children than in adults.

Subjective Symptoms.—If the polypus is small, the subjective symptoms are pretty much the same as in chronic suppurative disease of the middle ear. When they cause obstruction and pressure, there may be great pain excited in the ear and head, as well as severe tinnitus and giddiness.

Objective Symptoms.—If large, the red mass is seen in the external auditory canal, or protruding from the outer orifice (Fig. 101). When it is small, the purulent secretion requires to be removed and the parts dried, when we generally see the small red mass in the tympanic cavity. If very small and situated in some corner of the tympanic cavity, the growth may be difficult to recognise. It is generally necessary to use the probe (Fig. 102) in order to make quite sure of its existence. In using the probe, great caution should be exercised, and the interior of the ear must be thoroughly illuminated, so that the eye may

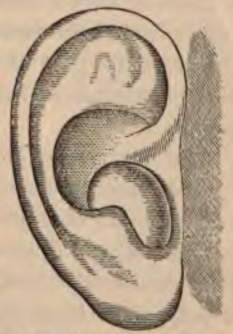

FIG. 101.—Large polypus projecting from external auditory canal.

guide the hand. With the probe we are able to move the growth, and thus distinguish it from simple hypertrophied tissue, or swollen mucous membrane. By moving the point of the probe cautiously round the growth we are also frequently able to determine its attachment, although in some cases the exact point of attachment of a polypus cannot be ascertained, until after the treatment has been carried on for a time. Associated with a polypus there is generally considerable destruction of the membrane; there may, however, be a very large polypus and a very small perforation. In this case, after the polypus has grown through the perforation out of the tympanic cavity, the aperture in the membrane becomes less in size, so that its edges constrict the growth, which, continuing to increase, at length covers the outer surface of the membrane like a mushroom. In examining such a case we are liable to be deceived, and to conclude that the membrane is totally gone. On removing the accessible part of the growth, however, it is found that the membrane is intact with the exception of a small perforation.

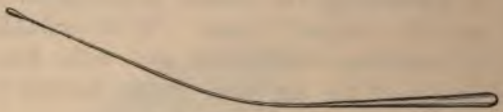
FIG. 102.—Aural Probe.

The discharge from the ear, where polypi exist, is frequently slightly tinged with blood.

Course and Consequences.—Such growths sometimes form very rapidly, and have been known to attain the size of a bean in a week or two. Von Tröltsch relates a case, in which a polypus so large as to project from the outer orifice of the ear formed in six weeks. Their growth is, however, usually more slow, and, after they have reached a certain size, they frequently become stationary. It is observed that the imperfect removal or treatment of a polypus may have the effect of stimulating it to greater and more rapid growth.

A polypus occasionally separates spontaneously, and comes away during syringing; in such cases the pedicle has been thin and the head of the growth large. The writer has seen a pretty large polypus, situated in the postero-superior part of the tympanum, disappear spontaneously after an attack of suppurative inflammation in the mastoid cells, which led to an opening in the cortical part of the mastoid cells behind the auricle.

While a polypus in the ear may exist for many years without producing serious mischief, it may, on the other hand, lead to important and even fatal consequences by obstructing the passage outwards of purulent secretion. In this way there may be brought about retention with caseous change of the purulent secretion, caries or necrosis, or extension of the purulent inflammation to the interior of the cranium or to the large vessels. Calcification or ossification of a part of the growth has been observed.

Diagnosis.—The occasional appearance of blood in a purulent discharge from the ear should excite suspicion of the presence of a polypoid growth. The objective examination, with the use of the probe, however, places the question beyond doubt.

Prognosis.—In most cases complete and permanent removal is effected by proper treatment. For the prognosis of the suppurative disease associated with these growths see p. 356.

Treatment.—This includes, 1st, the removal of the growth; 2nd, the destruction of its root in order to ensure complete eradication; and, 3rd, the removal of the cause.

1st, *The removal of these growths* may be brought about either by operative measures or by the application of caustic substances. The most common and most effective operative measure is the use of Wilde's snare, as described in the chapter on methods of treatment at page 138. In the removal of small soft polypi, or of the remains of larger ones after the snare has been used, such forceps as those represented in Fig. 103 are very useful, and sometimes sufficient if we be careful not to employ much traction. *Toynbee's lever ring forceps* (Fig. 104) are convenient for the removal of small polypi, especially where the canal of the ear is very narrow. Politzer employs a small ring knife (Fig. 36*c*) for

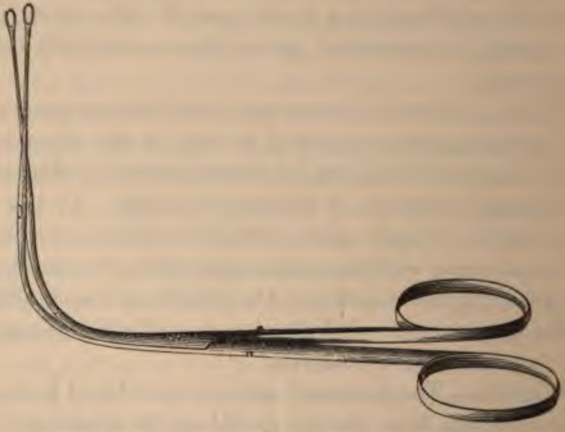

Fig. 103.—Forceps for removing small polypi.

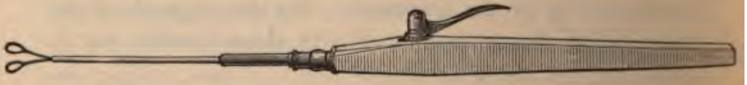

Fig. 104.—Toynbee's lever ring forceps.

removing small polypi from the walls of the external auditory canal. The ring-knife is pressed over the growth, which is then quickly sliced off.

2nd, *The thorough destruction of the root* is to be effected by means of caustic substances, or by the galvano-caustic apparatus. Immediately after the removal of the growth and after staunching the hæmorrhage, the insufflation of finely powdered alum is useful, both for preventing further bleeding and helping to shrivel up the remainder of the growth. This is probably the best application, until we have removed as much of the growth as possible with instruments, when the substances about to be mentioned are more effective. Before the application of a caustic substance to the root of a polypus, the latter must be carefully dried with absorbent cotton. The medicinal caustics most frequently used for destroying the roots of polypi are chromic acid, chloro-acetic acid, solid nitrate of silver, and perchloride of iron. The favourite one with the writer is chromic acid, applied in the form of crystals, or of a very concentrated solution, on the point of a thin cylinder of cotton fixed on a cotton holder, or on the point of a probe. We must carefully avoid touching the neighbouring tissue. If severe pain is excited, a syringeful of warm water will at once relieve it. The chromic or chloro-acetic acid generally requires to be applied six or eight times, at intervals of three days, before the thickened base of the polypus is removed. The solid nitrate of silver has a less intense, because a more superficial, effect than either of these two acids, and it sometimes occasions very considerable pain, which may continue for several hours. The most convenient method of applying the solid nitrate of silver to the interior of the ear is by fusing a portion on the roughened end of a probe made of steel, platinum, or aluminium. The point of the probe is first held in a flame till it is almost red-hot, and then gently pressed upon a piece of solid nitrate of silver, when a portion of the latter is fused, and, on cooling, the caustic forms a thin layer adhering to the point of the probe. The nitrate of silver should be applied daily for a fortnight.

Politzer speaks very highly of the efficacy of perchloride of iron for destroying the roots of polypi or granulation tissue. He applies it in the form of crystal or a strong solution, on the point of a probe or cylinder of cotton. A small dark crust is formed, separation of which, either spontaneously or with the help of a probe, should be followed by a fresh application of the substance. The use of the iron must be continued, until complete destruction of the morbid tissue is effected. Lucæ speaks highly of the solid sulphate of copper. The writer sometimes employs a small sharp spoon (O. Wolf) to scrape away a portion of the root before cauterizing (Fig. 36*b*).

When the morbid tissue is soft and cellular, these applications are usually quickly effectual in bringing about its disappearance. On the other hand, when it is dense and fibrous in character, the most prolonged use of these substances may end in failure. In these cases, which are comparatively few in number, no caustic is so effective and advantageous as the galvanic cautery applied in the manner described at page 124.

The treatment of polypi by *rectified spirit* is highly spoken of by some writers. They claim for it that even large polypi may, by long-continued use, completely disappear. After thorough drying of the parts, fifteen minims of the spirit (warmed) is poured into the ear, and allowed to remain there for twenty or thirty minutes—this being repeated twice or thrice daily. While the roots of polypi or small granulations may, by very prolonged use, be successfully treated by the rectified spirit, it does not accord with the experience of the writer that large polypi are got rid of in this way. He has seen it tried in such growths for a period of months, resort to Wilde's snare and caustic being after all necessary. In cases where operative treatment is rendered impossible, as in young children, or when the external auditory canal is very narrow, or when the patient resides at a distance from the surgeon, and cannot remain under his personal supervision for two or three weeks, the treatment by rectified spirit should be tried, the patient having been carefully instructed in the thorough drying of the parts, and in the proper application of the remedy. As a mode of treating granulations or the roots of polypi this treatment presents much greater likelihood of success than in causing the disappearance of growths.

3rd, *The removal of the cause* is an essential part of treatment, if we aim at complete and permanent cure. Remedies must therefore be diligently employed for the removal of the suppurative disease, on which the growths depend. The reader is referred to the description of the treatment of chronic suppurative inflammation of the middle ear for details.

2. Caries and Necrosis.

Disease of the osseous framework of the middle ear is, in nearly all cases, the consequence of an acute or a chronic suppurative inflammation of the mucous membrane—especially inflammation associated in its origin with scarlet fever or pronounced scrofula. Just as we find in other bones of the body that caries or necrosis is usually secondary to inflammation of the periosteum or soft parts over the bone, so in the temporal bone caries or necrosis is usually the result of inflammation either of the mucous membrane (the deeper layers of which perform the functions of periosteum) lining the middle ear, or of the periosteum covering the outer cortical part of the mastoid process. It is most frequent in childhood, and, when met with in adults, it is found in many cases to have originated in childhood. Caries and necrosis frequently co-exist in the same person.

Considerable portions of the temporal bone are sometimes exfoliated in a necrosed state. The annexed engraving shows the annulus tympanicus, with a portion of the mastoid process, exfoliated from a child, a patient of the writer's, who suffered from chronic suppurative disease of the middle ear, originating in scarlet fever a year before. Cases are recorded by various writers of large portions of the temporal bone being exfoliated. Gruber relates one, in which the whole of the mastoid process, with the groove for the lateral sinus on its inner surface, was exfoliated. The cochlea, from its more intimate relation to the tympanum, is necrosed more frequently than either the vestibule or the semicircular canals. Toynbee, Wilde, Voltolini, and others relate instances, in which the whole osseous labyrinth came away as a sequestrum. Large fragments of necrosed bone are sometimes found in the interior of the temporal bone after death. It is to be noted that, while a small carious aperture in the inner wall, or especially in the roof of the tympanum, may have a fatal issue, large portions of the osseous framework of the ear, in the form of sequestra, may come away without danger to life, although usually with serious injury to, or complete destruction of, the power of hearing.

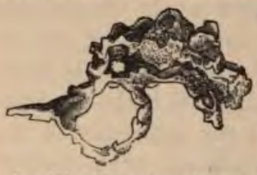

FIG. 105.—Sequestrum from a child.

Diseased bone is met with most frequently in the mastoid region, especially in the convex surface behind the auricle, and (although not so commonly) in the postero-superior wall of the osseous external auditory canal. Probably this frequency in the mastoid process is due to the action of stagnant, decomposing pus, which is so likely to collect and be retained in the interior of this bone. The walls of the tympanic cavity, especially the inner and upper, may also be affected with caries or necrosis. There may be one or two small circumscribed carious spots on either of these walls, or there may be a thin lamina of necrosed bone exfoliated from the promontory. In fatal cases of ear disease the roof of the antrum mastoideum and the inner wall of the mastoid cells are frequently found perforated by caries.

The *ossicula* are frequently affected. The disease may be limited to a small carious spot in one of them, or the whole of the ossicula may be disarticulated and swept away. This may happen even as early as a few weeks after the beginning of the suppurative process, especially when it originates in scarlet fever. It is not surprising that, when, as in purulent collections in the tympanum, the delicate small bones are constantly saturated with pus or loaded with granulation tissue, erosion or necrosis should take place, or that they should become dislocated and come away. Of the three ossicula, the stapes is least frequently lost, and its foot-piece generally remains, even after the head and crura are gone. The long process of the incus is particularly liable to destruction, owing to its length and slenderness. The head of the incus is often affected along with the head of the malleus. The head of the malleus is more frequently destroyed than the handle. As the result of absorption by caries, or of the removal of sequestra, great enlargements of the cavities of the ear may take place. The antrum mastoideum may be immensely widened, and the partition between it and the external canal destroyed. The accompanying woodcuts (Figs. 106 and 107) show a striking examples of these effects. On the other hand, caries or necrosis may result in new formation of dense osseous tissue. The mastoid cells may be converted into ivory-looking bone (see Fig. 106*b*), and the tympanum and external auditory canal may be obliterated by such hyperostotic growths resulting from caries or necrosis.

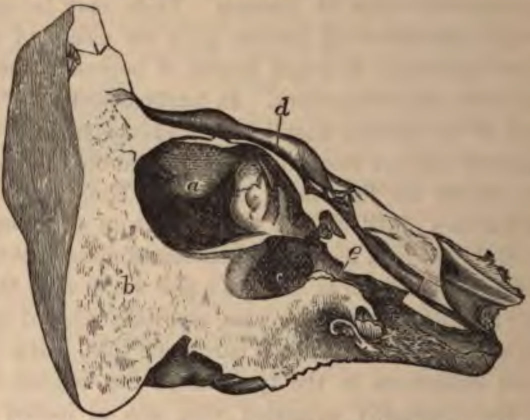

FIG. 106.—Inner half of section of temporal bone from a man, who died of purulent meningitis consequent upon chronic suppuration of middle ear. *a*, Inner wall of enlarged antrum mastoideum; *b*, mastoid cells converted into ivory-looking bone; *c*, tympanic cavity; *d*, roof of antrum mastoideum; *e*, inner wall of osseous part of Eustachian tube.

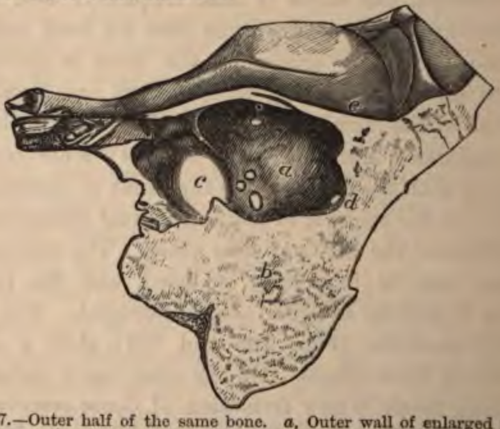

FIG. 107.—Outer half of the same bone. *a*, Outer wall of enlarged antrum, with carious perforations; *b*, mastoid cells converted into ivory-looking bone; *c*, lumen of external auditory canal; *d*, carious opening penetrating outer wall of antrum; *e*, dura mater.

Subjective Symptoms.—The subjective signs of caries or necrosis are pretty much the same as those of chronic suppurative disease of the middle ear. In extensive necrosis, or destruction of the ossicula, the deafness may be total, and, if the osseous labyrinth is involved, there is no perception by osseous conduction. Cases are recorded of convulsions having been caused by the presence of necrosed bone, and disappearing on its removal. While there may be complete absence of pain, there are cases, on the other hand, in which intense pain both in the ear and side of the head is complained of, not explained by such causes as acute inflammation or retained secretion.

Objective Symptoms.—The objective signs are more important than the subjective. In disease of the osseous walls or ossicula of the tympanum, when the affected parts are not exposed to view or accessible to touch, the objective appearances may be in no way different from chronic suppurative inflammation of the middle ear, namely, the presence of secretion, perforation of the tympanic membrane, granulations, &c. If the carious or necrosed part is within the field of vision, the practised eye may detect it even without the use of a probe. But the use of a probe is often essential, and the sensation of roughness, and perhaps of mobility, often gives positive evidence of the presence of necrosed bone or of a sequestrum, while the sensation conveyed by the touch of the probe on a gritty, soft, and depressed carious part, gives clear indication of the nature of the disease. In using the probe, where caries of the tympanic walls or ossicula is suspected, the greatest caution and gentleness should be exercised. We must on no account examine the tympanic structures with the probe without illuminating the interior of the ear, so that the eye may guide the hand. By the incautious use of the probe the tympanic membrane may be perforated, the ossicula dislocated, and the interior of the labyrinth or even of the cranium broken into. There is less danger in using the probe to the walls of the external auditory canal, except the upper wall, where, in consequence of the juxtaposition of the cranial cavity, very slight pressure should be exerted on any carious part.

The character of the discharge may sometimes yield information. It is often thin, brown, and copious. If it is frequently or persistently sanious, in the absence of granulations or polypi, there is ground for suspicion of diseased bone. An offensive odour from the discharge is not, as is believed by some, trustworthy evidence of the existence of osseous disease. Fœtor of the discharge is, in most cases, merely an evidence of want of thorough cleansing. The presence of osseous particles in the discharge shows the existence of caries or necrosis. These particles may be known to be present by a gritty feeling, when the pus is pressed between the fingers. Elastic fibres or osseous molecules may sometimes be recognised by the microscope. The determination of the presence of lime compounds in the sediment of the discharge by chemical reagents, as proposed by von Tröltsch, is rarely practicable.

Exuberant granulations, often pretty much of the nature of polypi, are frequently found over the seat of caries or necrosis. So long as a carious disease exists or a sequestrum remains, these growths, although removed, quickly recur. The cure of the caries, or the removal from the ear of the sequestrum, is, however, generally followed almost immediately by spontaneous disappearance of the granulations or polypi.

When the disease is in the part of the mastoid process forming the postero-superior portion of the osseous external auditory canal, there is often found in that situation a saccular or elongated bulging, which may be so large as to close the canal. This is caused by a collection of matter over the diseased bone under the periosteum. After this swelling bursts or is artificially opened, a permanent opening is left, over which granulation or polypoid tissue sprouts. With the probe introduced into the opening, we usually detect carious or necrosed bone. Owing to a considerable amount of diffuse swelling of the cutaneous lining of the cartilaginous part of the external auditory canal there is sometimes great difficulty in reaching the deeper parts of the ear. On pressing a small speculum between the swollen walls of the canal we may only see red granulation tissue, which bleeds on touching with the probe, thus rendering the examination still more difficult.

Disease in the mastoid process more frequently manifests itself behind the auricle than in the external auditory canal, although it may exist in both parts at one time. It may begin on the surface from an attack of periostitis, but more frequently it originates in the interior of the mastoid cells from acute inflammation, which ultimately affects the cortex. In either way a carious opening takes place, with or without the formation of a sequestrum. An abscess forms over the diseased bone, ultimately leading to an opening in the soft parts. There may be two or three ulcerated openings through the skin, which are frequently the seats of granulations, or they may be covered with crusts of dry secretion. A probe introduced into the opening in the skin may require to be passed to a considerable depth and to some distance from the outer orifice before it comes upon the diseased bone. The most common situation for the external opening is over the upper part of the mastoid process, but it may be at the lower part or even below the auricle, from the sinking of the abscess. In these cases the integument over the mastoid region, and sometimes extensively over the neighbourhood, is more or less red, swollen, and hard, or soft and fluctuating. The auricle usually projects from the side of the head, owing to its being pushed out by the swollen tissue immediately behind it. The osseous tissue in the neighbourhood, especially over the root of the zygoma, may be thickened, and there is often great induration and swelling of the glands in the region below the auricle, or in the parotid region. Abscesses may form in those parts, which may or may not have direct communication with the seat of the caries or necrosis. These abscesses may burst into the canal of the ear through its cartilaginous wall, as well as externally.

Course.—The course of the disease in the bone is sometimes very rapid. A large sequestrum may be formed in a few weeks from the beginning of the purulent disease, or, in as short a period of time, the whole of the ossicula may escape from the ear. The course is, however, most frequently slow, extending over a period of many months or years. The opening behind the ear sometimes appears closed for a time as if recovery had taken place; but soon the discharge again appears, the closure having been due either to a scab or to a very thin bulging cicatrix. The exfoliation of a sequestrum is usually attended by distinct improvement in the suppurative process. It is sometimes found that the occurrence of a carious opening in the outer cortex of the mastoid process not only has an excellent effect on suppurative disease in that cavity, but also seems to bring about the healing of caries in the tympanic walls. Severe inflammation, attended with intense pain, may attack the mastoid region during the course of the disease, from retention of secretion, irritating applications, or from cold. When the disease over the mastoid process terminates in recovery, there is left a depressed firm cicatrix adhering to the bone. On examining this cicatrix with the finger, we usually find a distinct hollow in the bone.

Consequences.—The effects of the disease upon the cavities of the ear have been already spoken of. We shall further on have to describe more fully the possible danger to life, which may result from caries or necrosis. This danger is especially serious, when the disease is situated in the osseous partitions, which separate the dura mater or large vessels from the middle ear, the roof and the inner wall of the tympanum. Facial paralysis, when due to chronic suppurative disease of the middle ear, is frequently brought about by caries or necrosis involving the osseous walls of the Fallopian canal. There has also to be mentioned the possibility of disease of the internal organs, such as the liver or kidneys, being caused by long-continued caries of the walls of the middle ear.

Prognosis.—The prognosis must be considered in view of all these possible consequences. While, in the situations mentioned, caries or necrosis is fraught with danger to life, experience has, on the other hand, shown that a carious disease may exist for many years, even from youth to old age, without any serious consequence, the patient dying from another disease altogether. In children there is a much greater likelihood of recovery both from caries and necrosis than in the adult. The presence of a markedly scrofulous, tubercular, or syphilitic diathesis has, of course, a very unfavourable influence. In a very large number of cases of carious perforation of the cortex of the mastoid process behind the auricle, complete cure and cicatrization ultimately take place.

Treatment.—The treatment of caries and necrosis is in many respects the same as that of chronic suppurative inflammation of the middle ear. The thorough cleansing away of accumulated or retained secretion is of the first importance. In order to gain proper access to the interior of the ear through the external auditory canal, a slender India-rubber tube should be affixed to the nozzle of the syringe, and introduced through the canal of the ear. If the swelling of the walls of the canal is very great, efforts must be made to dilate the canal, either by introducing a series of cotton plugs, smeared with a suitable ointment (f. 26), and gradually increasing in thickness, or, if necessary, by incising the most bulging portion of the swelling in the walls of the canal. It may be necessary to keep a proper drainage tube in the external auditory canal. Politzer strongly recommends the injection of warm water, or of a weak solution of borax (f. 58), through the Eustachian tube, with a catheter, where there is caries associated with caseous accumulation and great pain. Lucæ employs repeated and long-continued applications of a solution of sulphate of copper, while Volkmann speaks highly of the effects of a weak solution of hydrochloric acid. If an abscess has formed either in the postero-superior wall of the canal, or in the mastoid process behind the auricle, it should be opened (in the latter place antiseptically), and an examination made with the probe in order to ascertain the state of the bone. If we find a carious opening behind the ear, and if fluid injected into it finds its way either out at the external auditory canal or through the Eustachian tube, antiseptic injections must be employed and continued regularly for a length of time. The point of the syringe should be guarded with India-rubber tubing, and, if obstruction is found to exist, too much pressure must not be employed. Injection in the reverse direction may also be employed, that is by fitting the nozzle of the syringe, guarded with India-rubber, into the external auditory canal, and forcing the fluid through the mastoid cells and out by the carious opening. Our efforts should aim mainly at keeping the carious opening, the mastoid cells, the tympanum, and the external auditory canal free from any kind of obstruction, so that the secretion may find an exit, and that cleansing and disinfecting fluids may be freely introduced. As facilitating this object we must, if possible, remove swelling, granulations, or polypi, which may exist in the tympanic cavity or external auditory canal. If the perforation in the tympanic membrane is small, it may have to be enlarged. The carious opening may also have to be enlarged by means of a small chisel or sharp spoon, and a drainage tube kept in. The opening in the soft parts, if insufficient, should be enlarged, and kept free from granulation tissue.

Sequestra must be removed only after they have become thoroughly separated. Care must be exercised in attempting to remove sequestra from the external auditory canal. If a long thin piece of necrosed bone lies across the canal, forcible pulling with forceps may thrust the points of the thin bone into the walls, injuring the skin of the canal, and possibly exciting severe inflammation. To avoid this, sequestra of such a shape and in such a position should first be crushed with strong forceps, after which removal becomes easy and safe. The remarks on the removal of foreign bodies from the ear may here be referred to, and the instruments there recommended are also useful in removing pieces of necrosed bone. If the sequestrum is in the interior of a fistulous orifice in the mastoid process, and if it is too large to escape by that orifice, the sequestrum must be crushed

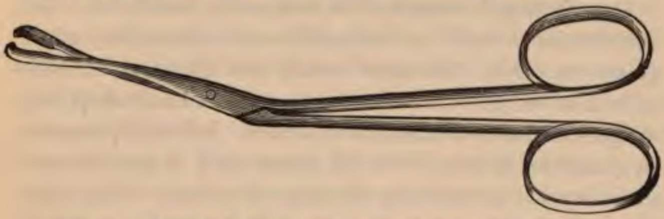

FIG. 108.—Forceps for removing sequestra from mastoid process.

into smaller pieces, or the carious opening widened (see p. 144).

From the posterior wall and floor of the external auditory canal small circumscribed parts of caries may be scraped away with advantage and safety, but in the roof this method of treatment should be avoided. Neither is it safe to employ it on the walls of the tympanum. The sharp spoon of Wolf (Fig. 36*b*) is the most suitable instrument, and it is well not to penetrate further than from one to two millimètres. The galvanic cautery may also be employed to arrest the carious process. After scraping or burning, the application of a layer of iodoform forms a good dressing.

Constitutional treatment is frequently beneficial. Any constitutional defect or cachexia must be treated by appropriate remedies. We shall usually find that such remedies as iron or cod-liver oil, with country air and nutritious food, are powerful aids to the local treatment. Iodide of potassium in quantities of from 8 to 15 grains daily is sometimes of great service in relieving the pain (Politzer). Experience proves that caries and necrosis of the mastoid process, especially in the case of children, are frequently, under the treatment which has been described, quite recovered from.

3. Caseous and Cholesteatomatous Masses.

Another consequence of chronic suppuration of the middle ear is the formation in the cavities of the middle ear of masses, the products of changes in the purulent secretion, which has lain there for a great length of time. These collections are found chiefly in the upper tympanic cavity and antrum mastoideum; but they may exist throughout the whole middle ear. In a large number of cases the purulent secretion simply dries, and becomes changed into small caseous masses, smelling offensively, and mingled with abundant epithelial cells exfoliated from the mucous lining. This change may take place during the existence of the discharge from the ear, or the masses may gradually form out of the pus, which has been retained in these parts of the middle ear after the discharge has ceased. Such caseous debris is frequently found after death to occupy the upper tympanic cavity and the antrum mastoideum in persons, who have suffered from chronic suppurative disease of the middle ear.

The purulent matter may undergo changes of a different character. Lying stagnant in these spaces for a long period of time, it may undergo a fatty change with the formation of cholestearine, and, gradually inspissating, become converted into a substance like butter. Meanwhile, probably from the irritation caused by the pressure of the mass upon the walls of the middle ear, there is a rich proliferation and desquamation of epithelial cells, and, while the centre of the mass is formed of caseous-looking matter, which is gradually drying, the outer or peripheral parts become changed into a firm mass composed of stratified layers of large flat cells, with crystals of cholestearine, which impart a glistening, mother-of-pearl appearance. These masses, from the firm consistence which they sometimes present, have been mistaken for real tumours, the *sebaceous* or *molluscous tumour* of Toynbee, and the *perltumour* of Virchow. But they are not true tumours—they are really changed pus, with exfoliated epithelial cells.

We find in such cases crumbly or laminated masses, inside the perforation, part of which may be removed with the small sharp spoon, or washed away with the syringe. The syringe may day after day for some time bring away crumbly lumps, emitting an offensive odour.

These masses, enlarging peripherally, exert gradually increasing pressure on the walls of the middle ear, until the spaces of the middle ear, especially the antrum mastoideum, may become much distended from thinning and absorption of the walls. In time they may extend beyond the confines of the middle ear into the external auditory canal on the one side, or by pressure upon the roof and inner wall of the middle ear the masses may force their way into the middle or posterior fossa of the skull, and bring about a fatal issue. Caries or necrosis may be produced by these masses, or may be the cause of their formation. A fatal issue may result from the retention of pus, owing to such masses obstructing all means of outlet.

The *treatment* consists mainly in efforts to remove the collections by ordinary syringing, or by intra-tympanic syringing with disinfecting fluids (f. 50 to 53). By the latter method great quantities of caseous and laminated masses may be brought away, affording great relief to the sense of oppression and headache, frequently complained of by patients suffering from these formations.

4. Acute Periostitis over Mastoid Process.

Syn.—Periostitis Mastoidea.

This disease has its origin, in the great majority of cases, in acute or chronic suppurative inflammation of the middle ear, especially the latter. It is therefore most convenient to include it among the consequences of chronic suppurative disease.

While the inflammatory conditions, which affect the outer parts of the mastoid region, have generally their seat chiefly in the periosteum, they are occasionally limited to the cutaneous and subcutaneous tissue over the mastoid process. This affection is frequently associated with acute suppurative inflammation of the mastoid cells.

Causes.—If primary in its origin, which is rarely the case, the inflammation may be due to an injury or to the influence of cold. It is occasionally found as a complication of diffuse or circumscribed inflammation of the external auditory canal, the periosteal lining of which is directly continuous with that covering the mastoid region behind the auricle. It is, however, much more frequently due to the extension of inflammatory disease previously existing in the interior of the mastoid cells, and the inflammatory process is propagated from the lining of the mastoid cells to the periosteum covering the outer shell, either directly through the osseous tissue or by means of the connective tissue, vessels, &c., which penetrate the cortex. The gaps or fissures in the bone, often existing in childhood, especially the squamo-mastoid fissure, also facilitate the extension of inflammation from the interior to the exterior of the mastoid process.

Symptoms.—The first symptom is usually pain in the mastoid region, frequently of a very intense character, which shoots along the neighbouring part of the head; the surface of the mastoid process is also extremely tender to touch. The patient may be unable to sleep for nights together. The surface soon becomes red, swollen, hard, and œdematous. The œdema may extend a considerable distance beyond the mastoid region. In consequence of the swelling of the tissue behind the concha the auricle juts outwards and forwards from the side of the head. This is strikingly seen, when we look at the head from the front or behind; but it may escape notice, if we look at the ear laterally. There is usually more or less feverish disturbance.

Course.—In some cases the inflammatory symptoms subside without suppuration; but generally in the course of from a few days to two weeks pus forms either between the periosteum and bone or outside the periosteum. When there is only a small quantity of matter, the sense of fluctuation may be absent; but, on the other hand, fluctuation may apparently exist, and yet no pus may be found on incision.

The spontaneous opening of the abscess is in many cases long delayed, perhaps for several weeks. The opening generally takes place behind the auricle; but it may occur in the external auditory canal either at the postero-superior wall of the osseous portion, or through the cartilaginous part of the canal. In this case, on pressing the bulging over the mastoid process, matter is seen to issue from the canal of the ear. If no complication arises in the bone, recovery soon follows the complete emptying of the abscess.

Consequences.—But the periostitis may end in caries or necrosis of the outer shell of bone. If frequent relapses of the inflammation take place, there is reason to suspect caries or necrosis. The probe will, however, decide the question.

Diagnosis.—We must not confound with this disease the œdema, swelling, and even redness not unfrequently seen over the mastoid process, in connection with acute inflammation of the external auditory canal or of the middle ear. The intensity of the pain and the greater redness and swelling of true periostitis are usually sufficient to distinguish this disease. It must also be remembered that swelling and tenderness of the glands over the mastoid process are frequently seen in suppurative disease of the middle ear, and must not be mistaken for periostitis.

Prognosis.—Periostitis of the mastoid process without affection of the bone usually terminates in complete recovery.

Treatment.—In the milder cases, attended by little pain, we should employ the tincture or ointment of iodine (f. 6 and 23) over the mastoid region, and at the same time remove any obstruction, which may be found to exist, to the escape of secretion from the middle ear. Especially if we suspect retention of pus in the antrum mastoideum, the use of the intra-tympanic syringe in the direction of the antrum is called for. Politzer recommends, as abortive treatment, the repeated injection of warm water into the middle ear by means of the Eustachian catheter (see p. 110). Up till recently warm poultices or fomentations applied over the inflamed mastoid region have always been recommended, and they generally have a marked effect in relieving the pain. In Germany, however, the use of cold has for some years been practised in these and other acute inflammations of the ear, and this method of treatment is now being adopted in this country. Cloths dipped in iced water applied over the mastoid region and frequently changed, or Leiter's cooling apparatus, six coils of the tube being placed behind the auricle and three in front, are suitable means of applying cold. In employing Leiter's apparatus a piece of lint should intervene between the skin and the metallic tubes. By this mode of treating mastoid inflammations, at an early stage and when the symptoms are very acute, great relief is usually attained, the inflammation being not unfrequently cut short, and suppuration prevented. If subsidence of the inflammatory symptoms does not quickly follow upon the use of Leiter's cooling apparatus, local blood-letting over the mastoid region by means of leeches or Heurteloup's suction apparatus (see p. 104) should be carried out. When no marked improvement takes place in two or three days, the symptoms being very acute, a free incision made through the swollen infiltrated tissues down to the bone tends to cut short the inflammatory process with its attendant symptoms even before the stage of suppuration. This, on account of its having been first recommended by Wilde of Dublin, is usually known as *Wilde's incision.* A strong-bladed scalpel is used, and, if there is distinct fluctuation at any part, that position should be chosen for the incision. But, if no fluctuation is found, the best position for the incision is parallel with the auricle and about three-eighths of an inch distant from it. The cut should extend to from half an inch to an inch in length, and the tissues should be severed to the bone, which is sometimes at a considerable depth. If the posterior auricular artery is cut, pressure or torsion will usually suffice to check the hæmorrhage. The ligature is rarely required. On examining with the probe after the incision, we may find the bone rough or soft, or there may be an aperture in the cortex communicating with the mastoid cells, from which the pus may be coming, or the bone may be quite normal. After the incision a drainage tube should be inserted, in order to prevent premature closing of the wound and relapse of the disease, while antiseptic dressings are applied. If the pain in the mastoid region is not relieved by the incision, it may be necessary, after waiting a day or two, to perforate the outer shell of the bone (see p. 141).

More rarely the collection of pus take splace in the postero-superior wall of the osseous part of the external auditory canal. If there be marked swelling and pain in that situation, it should be incised. If an opening already exists in the external auditory canal, from which matter escapes, when the bulging behind the auricle is pressed upon, an incision may be unnecessary, as by sustained pressure upon the abscess we may bring about complete evacuation and healing. If caries or necrosis should result, appropriate treatment, such as that described at p. 395, must be carried out. Laxative and calmative medicines may be required. Complete rest is desirable and sometimes indispensable.

5. Acute Suppurative Inflammation in Mastoid Cells.

Syn.—Ostitis Mastoidea; Secondary Reactive Inflammation of the Mastoid Cells (Politzer); Acute Purulent Collection in Mastoid Cells.

The catarrhal and inflammatory affections of the middle ear, which have been already described, nearly always involve to a greater or less extent, by continuity of mucous membrane, the mastoid cells. Indeed, if chronic suppurative disease of the middle ear exists, the mastoid cells are seldom in a normal condition. In these cases, however, there are generally no definite subjective or objective symptoms referable to the mastoid region, except in the case of acute inflammation of the middle ear, when we not unfrequently find darting pain in the mastoid process, with tenderness on pressure or percussion.

But under the above heading we have to describe an acute inflammation in the mastoid cells, usually coming on in the course of an acute or chronic suppurative disease of the middle ear, attended, in most cases, with rapid formation of pus in the cells, manifesting itself by intense and even dangerous symptoms, and often leading to important consequences. The muco-periosteal lining of the cells is at first intensely red and swollen, and the osseous tissue frequently shares in the inflammatory process. After a time the cells become filled with purulent or muco-purulent secretion, granulations may form in their interior, while caries or necrosis frequently results. As after-effects we may have sclerosis of the mastoid process, or caseous or cholesteatomatous formations.

Causes.—During the existence of acute or chronic suppurative inflammation of the middle ear this disease may be excited (1) by obstruction to the exit of pus from the mastoid cells to the tympanum; (2) by the irritating action of decomposing caseous or purulent masses in the mastoid cells; (3) by irritating applications to the tympanum; (4) by injudicious syringing; (5) by the action of cold; (6) by an injury. Scarlet fever, tuberculosis, or syphilis predisposes to this complication, when suppurative inflammation exists in the ear.

Subjective Symptoms.—In most cases the subjective symptoms are very severe. There is violent pain in the mastoid region, shooting down the neck and over the whole head; there is also great tenderness on pressure or percussion. There is frequently also a most painful sense of fulness in the mastoid process. In severe cases there may be neither rest by day nor sleep by night. On the other hand, we find occasionally that the pain is not severe, and we are then apt to overlook the true nature of the disease. There is usually marked feverishness, sometimes with distinct rigors. There may also be severe giddiness, and in bad cases the patient looks alarmingly ill.

Objective Symptoms.—At first the soft parts over the mastoid process may be unaltered, but usually the inflammatory disease soon extends through the cortex to the periosteum and superficial structures, when the aspect becomes pretty much that of mastoid periostitis. There are redness, hardness, and œdema, frequently extending from the mastoid process over a considerable part of the neighbourhood. If the inflammation originates in the deep-seated cells, a considerable time may elapse, before it appears on the surface.

Course and Consequences.—While, in the slighter forms, the inflammatory process may subside, and pass away without suppuration, much more frequently a collection of pus forms, and, after great suffering on the part of the patient, makes its way either through the outer shell of bone behind the auricle, or, much less frequently, through the osseous wall of the canal, leaving a carious opening in either of these places. It rarely finds its way into the tympanic cavity, owing to the closure by swelling or otherwise of the aperture between the tympanum and the antrum. The collection of matter may occupy the whole of the interior of the mastoid process, or it may be limited to a particular portion. If it bursts through the apex, or through the inner surface of the lower part of the mastoid process (digastric fossa), which rarely happens in either situation, there is formed a deep-seated burrowing abscess under the muscles and fascia below the mastoid region. In children the rupture of the abscess through the outer shell of bone at the antero-superior part of the mastoid process is much more easy than in the adult. This is owing to the fact that the outer wall of the antrum mastoideum is much thinner in the child. Besides, the presence in the child of a suture in the outer wall (the squamo-mastoid) favours spontaneous perforation at this part. When a carious opening has thus formed in the outer shell of bone, the course is that described under the head of caries of the mastoid.

But extension of the inflammation, or the formation of a carious opening or of a sequestrum, may take place towards the cranial cavity, either in the direction of the shell of bone separating the mastoid cells from the lateral sinus, or through that forming the roof of the antrum. In either case a fatal issue would probably ensue. Caries may also extensively involve the osseous septa between the cells in the interior, while large parts of the interior or of the cortex may be converted into sequestra by necrosis.

Diagnosis.—When the superficial soft parts are involved in the inflammation, we can seldom distinguish this disease from mastoid periostitis, until after Wilde's incision has been made. When no change is perceptible in the tissues outside the bone, the symptoms being only of a subjective character, we can exclude the possibility of mastoid periostitis, although we are not able by examination to make out whether inflammation or suppuration exists in the interior of the cells. Perforation of the osseous shell is the only means as yet known for diagnosing in such cases the presence or absence of a purulent collection.

Prognosis.—When the patient is markedly scrofulous, tubercular, or cachectic, the prognosis is unfavourable. When the abscess is deep-seated, when there is an insuperable impediment to the escape of matter from the tympanum, as by exostosis or closure of the external auditory canal, or when great thickening or sclerosis of the external osseous shell exists, the prognosis is likewise unfavourable.

Treatment.—The student is referred to the description of the treatment of mastoid periostitis (p. 402) as in all respects appropriate here.

If, however, in spite of Wilde's incision, or of incision into the postero-superior wall of the canal, the urgent symptoms continue, namely, great pain in the mastoid region, rigors, fever, headache — we should not delay for more than twenty-four hours the operation of perforating the mastoid process. For details regarding this operation the student is referred to the chapter on Methods of Treatment in Part I., at page 141.

B. CONSEQUENCES EXTENDING TO PARTS OF THE BODY BEYOND THE EAR.

1. Paralysis of Facial Nerve.

We have included this among the consequences of chronic suppurative disease of the middle ear, because, when paralysis of this nerve is caused by an affection of the ear, that affection is most frequently chronic purulent disease, especially when this is associated with caries or necrosis of the osseous walls of the Fallopian canal. It is, however, met with, although less frequently, in connection with the acute form of suppurative inflammation, while occasionally it is a consequence of non-suppurative catarrh of the middle ear.

The intimate relation, both topographically and through the vascular supply, between the mucous membrane of the middle ear and the nerve, as it lies in the Fallopian canal, explains how it may become involved in congestive or ulcerative diseases of the middle ear. When the paralysis is caused by a non-suppurative disease, it is due either to hyperæmia of the sheath of the nerve, to the pressure of exudation, or to secondary contraction; when caused by a suppurative disease, it may be due to either of these, or to the pressure of necrosed bone, or to partial or complete ulcerative destruction of the nerve.

Symptoms.—The paralytic condition may come on suddenly, or there may be first twitchings in the affected muscles. The symptoms produced by pronounced paralysis are well known, and are chiefly due to the inaction of the facial muscles on the affected side. There is partial or complete inability to close the eyelids; drawing of the mouth to the normal side during facial movement; obliteration of the normal folds and furrows of the affected side of the face, especially the folds of the brow and the naso-labial furrow. These peculiarities are of course most marked during active facial movement, as in laughing or crying, when the blank expression of the paralysed side is very striking. Minor degrees of facial paralysis, such as a less distinct naso-labial furrow, associated with ear disease, are probably much more common than is usually supposed (Wilde). Different fibres of the nerve, having different areas of distribution, may be unequally affected: thus the brow and the eyelids may be more markedly affected than the mouth or cheek, *Treatment.*—This must be directed chiefly to the removal of the ear disease, which is the cause of the paralysis. With this object in view, catarrhal or suppurative diseases or diseases of the bone must be properly treated. If recovery from the paralysis does not follow the cure of the ear disease, faradic electricity should be tried, as well as counter-irritation by means of repeated vesication by cantharides applied over the mastoid process, or of the liniment or ointment of iodine to the same region. Electricity is, in some cases, productive of benefit in these later stages of facial paralysis due to aural disease. The internal use of iodide of potassium (5 to 10 grain doses) is also said to have sometimes a beneficial effect, and should, in the more persistent forms, be tried.

2. Fatal Consequences.

The fatal consequences, which may arise from suppurative disease of the middle ear, are the following:—

CEREBRAL ABSCESS.
PURULENT MENINGITIS.
PHLEBITIS, THROMBOSIS, EMBOLISM, PYÆMIA.
TUBERCULAR DISEASE.
HÆMORRHAGE.

When we study the anatomy of the middle ear (see p. 266), we can understand how ready a means for the extension of inflammatory disease is provided by the peculiar position and relations of the various parts of the interior of the ear, and how especially the structure of the temporal bone is fitted to aid in the accumulation and decomposition of purulent matter, which may be then absorbed into the general circulation.

In regard to the proportion of cases of purulent disease of the middle ear, which have a fatal termination, we do not yet possess reliable or definite statistics. It is calculated, however, that half of all cases of cerebral abscess have an aural origin, while the literature of the subject contains accounts of many cases of fatal purulent absorption, of the formation of thrombi in the vessels, and of metastatic abscesses in the joints, lungs, and other parts of the body, all of which have sprung out of chronic suppurations in the ear. There can be no doubt, however, that death is not unfrequently the result of such morbid conditions of the ear in cases where the existence of the otorrhœa has not been mentioned to the physician, or when both patient and practitioner were ignorant of the dangers so often attendant upon a "running ear." There are probably few practitioners of experience, who have not seen in their practice fatal disease of the brain, or of the meninges, or pyæmia, arising from suppurative diseases of the ear.

Cerebral Abscess.

The interior of the cranium is the most frequent direction, in which extension of disease of the ear leads to a fatal issue. We have already pointed out the anatomical reasons for this, especially the peculiarity of structure and relations of the osseous partition separating the mucous membrane of the middle ear from the dura mater. Probably more frequent extension of middle ear disease to the dura mater and brain would take place but for two causes—1. the resistance offered by the strong fibrous tissue composing the dura mater, the power of resistance being often increased by a process of thickening of its tissue over the diseased ear; and, 2. the thickening of the lining membrane and osseous walls of the middle ear, by which the morbid process becomes circumscribed, and a barrier is provided against its extension. Post-mortem examination has not unfrequently proved that caries and necrosis may exist immediately

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The extension to the interior of the cranium takes place most commonly through the *roof* of the middle ear, and, next in frequency, through the *inner wall,* which separates the mastoid cells from the dura mater. The mode of extension is by no means always that of a carious opening, as in a considerable proportion of cases no caries is discovered, the propagation of the disease taking place through the vascular, lymphatic, or connective tissue, penetrating the osseous partitions.

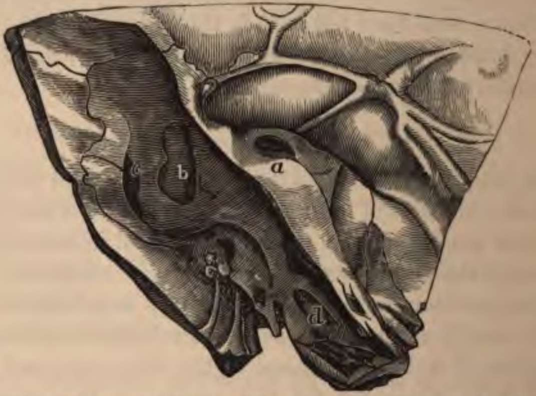

FIG. 109.—Left temporal bone, showing caries of roof and inner wall of mastoid cells, consequent upon suppurative disease of middle ear. *a,* carious opening in roof of tympanum; *b* and *c,* carious openings in inner wall of mastoid cells; *d,* internal auditory canal.

A cerebral abscess due to ear disease is most frequently situated in the part of the brain directly above the roof of the middle ear, namely, the temporo-sphenoidal lobe. It is, however, not unfrequently in the cerebellum, and sometimes in the corpus striatum. Several abscesses may be found near to one another. Of eighty cases, reported by

Lebert,* nearly a fourth were multiple. The dura mater and brain substance, intervening between the abscess and the source of the disease in the ear may be quite healthy; more frequently, however, the brain substance is dark and softened, and the dura mater soft and pulpy. Over the roof of the middle ear the brain substance, dura mater, and bone may be firmly adherent to one another. The osseous partition between the middle ear and the dura mater is also usually dark in colour from the action of the gases of decomposition upon the osseous salts. If a carious opening exists, the dura mater over it may be simply soft, thick, and pulpy, or it may be perforated with small holes. Cases are recorded, in which the abscess existed on the opposite side of the brain from the ear affected. These metastatic abscesses in the brain, where apparently healthy tissue intervenes between the abscess and the ear, probably owe their existence to the transference of vibriones or bacteria from the ear by means of the blood and lymphatic vessels, or by septic embolism originating in a thrombus in the vessels of the ear.

In rare cases there has been found a fistulous communication between an abscess in the central part of the brain and a carious opening in the roof of the middle ear, when by syringing the ear liquid may be forced into the interior of the cranium. It was at one time believed that, in such cases, the abscess in the brain was the primary condition, and that, after making its way through the roof of the middle ear, it reached the external auditory canal, giving rise to the so-called "otorrhœa cerebralis." There is little doubt, however, that in all such cases the brain abscess was a secondary condition, resulting from purulent disease in the middle ear. Generally the contents of the abscess are of the nature of dirty greenish decomposing pus, which emits a most offensive odour. The brain substance in the neighbourhood is often much softened and dark in colour. In the chronic forms (latent) there is a thick pyogenic lining encapsuling the abscess, and forming a boundary wall between the healthy brain substance and the abscess. Cerebral abscess is most frequently met with in persons under thirty years of age, that is, when suppurative diseases of the ear mostly prevail.

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* See "Ueber Gehirnabscesse" in Virchow's *Archiv*, vol. X., pp. 78, 352, and 426.

Symptoms.—There may be extensive destruction of brain substance from the formation of an abscess without any symptom of cerebral disease. This is especially so in the *latent* form, in which for a long time there may be no complaint other than that of occasional pain in the head, increased pressure, and of more or less giddiness. Symptoms of cerebral irritation or depression, such as convulsions or apoplectic phenomena, may appear only a few days, or even hours, before death, and may be due to sudden bursting of the abscess into the lateral ventricle. In the more *acute* forms the onset of the disease is usually signalized by pain in the head and vomiting. These often begin after some injurious influence from without, such as a blow on the head or ear, or exposure to cold, or after violent exertions. In some the pain is most intense, and continues till near death. It is, in most cases, confined to the side of the head corresponding with the seat of the abscess, and, if this is in the cerebellum, the pain often extends to the back of the head. In the later stages of the disease the pain usually disappears. Vomiting is present at the commencement in a large proportion of cases, continuing for several days, although it is not so constant a symptom as pain. In many cases there is slight shivering, with intermittent feverishness. In some cases, especially when associated with phlebitis, the shiverings are very marked. Giddiness is also not unfrequent.

There is probably less disturbance of the intelligence in cerebral abscess than in other diseases of the brain. Only in a fourth of Lebert's cases was there distinct delirium. In one of the writer's cases *aphasia* was noticed as one of the phenomena. In this case, although the convolution of Broca was not involved directly in the abscess, the pressure exercised on this part by the collection of matter in the immediate vicinity probably accounted for its function being involved.

There is usually in the earlier stages great intolerance of light, and the pupils are frequently small. In the later stages dilatation and inequality are observed.

Drowsiness, stupor, and ultimately coma, with or without epileptiform or paralytic phenomena, are almost invariably present in some stage of intra-cranial abscess. In all the cases, which the writer has observed, death took place by coma. Sometimes, instead of distinct convulsive attacks, there are general tremors, more like severe shiverings, along with drowsiness, stupor, or coma. Sometimes we see frequent repetitions of the comatose condition, with intervals of consciousness. Paralytic phenomena are not so frequently observed, probably occurring in about half of the cases, and usually follow a comatose seizure. They are generally hemiplegic in character. When the face is paralysed, it is usually on the side corresponding to the affected ear. Paralysis of the sphincters generally precedes by a day or two the fatal termination.

The duration of acute cerebral abscess ranges from two to four weeks. In the three last cases, which came under the writer's notice, the duration was respectively eleven, thirteen, and twenty-one days. But the disease sometimes runs an irregular course for months.

Cerebral abscess may be confounded with meningitis or an intra-cranial tumour. There is probably more intense and localized pain in cerebral abscess than in meningitis; but it may be impossible to distinguish them, and, indeed, both may co-exist. With respect to intra-cranial tumour, we may say that, if a suppurative ear disease exists and the symptoms are acute, the probability is rather in favour of an abscess than a tumour.

The *treatment* of cerebral abscess is included in the description of the treatment of purulent meningitis.

Purulent Meningitis.

While in this disease the inflammation primarily and specially affects the dura mater, it generally also attacks the pia mater and brain. The brain substance over the diseased meninges is usually softened or œdematous. The dura mater is either thickened and pulpy, or it becomes ulcerated, and sieve-like perforations are found over the darkened or eroded bone, exposing the pia mater and brain to the morbid process. The meningitis is most frequently local, and confined to the middle and posterior fossæ of the cranium, but it may extend to the whole of the base, and sometimes even to the convexity. A collection of fœtid pus is usually found under the dura mater, either in contact with the inner surface of the mastoid process and posterior surface of the petrous bone, or over the roof of the middle ear. The dura mater is usually separated from the bone by the collection of pus, and the brain above is subjected to pressure, or the purulent collection may be on the inner surface of the dura mater. While the disease is in many cases the result of a carious opening communicating with the purulent process in the middle ear, it has been long established by numerous observations in the dead body that suppurative diseases may bring about fatal meningitis without a carious affection. The disease may in these cases be conducted to the dura mater by the numerous foramina in the bone for the passage of vessels, nerves, and connective tissue, or by the fenestral openings.

Symptoms.—The symptoms very much resemble those manifested in acute cerebral abscess. Indeed we have here, as in the latter condition, an abscess pressing on the substance of the brain, and therefore likely to cause phenomena similar to a collection of matter in the interior of the brain, the difference being one of position. The symptoms usually begin with severe pain in the head, sometimes general, but not unfrequently local and limited to the side affected. Giddiness, which may be so great as to cause staggering, is often also experienced at the first. Vomiting is a very frequent symptom, and may last during the first three or four days, everything being expelled from the stomach, while mucous and bilious matter is brought up not connected with the taking of food. The bowels are usually confined during the course of the disease, and the abdomen frequently becomes retracted. There is generally great thirst but no appetite, the temperature of the skin is at first increased, though the degree of heat is variable, and the face is often flushed and pale by turns. The pulse is quick at the beginning, afterwards slow and irregular, but towards the end it again becomes rapid. At the early stage there is usually a creeping or shivering sensation, and at the end of the first week there may be severe rigors followed by heat and sweating. Drowsiness and stupor come on after a few days; but at first the patient is generally easily aroused, and then gives intelligent answers to questions. While there may be drowsiness, there is no sound sleep. Tremors or convulsions with partial or complete unconsciousness usually occur at some period. In one of the author's cases there were repeated attacks of rigors or tremors affecting the whole body, during which the patient was unconscious, with stertorous breathing, the eyes being half open and the eyeballs turned up. Stiffness of the muscles of the neck and retraction of the head are occasionally observed. There may be hemiplegia or complete general paralysis. The pupils may be sluggish, or immovable, or unequal. Optic neuritis is not an uncommon symptom. The patient usually sinks into complete coma with fixed and dilated pupils some time before death. It is to be remembered that the whole of these symptoms are rarely present, and in some cases the symptoms are very obscure.

The duration of the disease is a variable one. Some cases terminate fatally in from three to four days, while others extend over as many months. Probably most cases run their course in from three to four weeks.

While the *prognosis* is usually extremely unfavourable, experience shows that recovery may take place, even when, in the course of a suppurative disease of the ear, such alarming symptoms as fever, headache, convulsions, and coma show themselves. Such cases, however, it is to be admitted, are usually connected with acute, not chronic, processes in the ear, and are probably dependent on simple congestion of the meninges or brain, not attended by purulent formation.

This disease cannot be distinguished with certainty from abscess in the brain or tubercular meningitis. It may be confounded at the earlier stages with typhoid or typhus fever; but the progress of the disease and the history of the ear disease usually clear up any such diagnostic difficulty.

Treatment of Cerebral Abscess and Purulent Meningitis.—When symptoms manifest themselves, which arouse the suspicion of an intra-cranial complication, we should first adopt prompt measures to remove, if possible, any obstruction which may exist to the escape of purulent matter from the interior of the ear, and thoroughly cleanse and disinfect the tympanum and mastoid cells. For this purpose, polypi must be removed, perforations enlarged, and carious openings in the mastoid process widened if necessary. If there are any symptoms of retained secretion in the mastoid cells, as purulent, caseous, or cholesteatomatous masses, we should, in order to give the patient every chance, perforate the mastoid process, and wash out the interior.

In the direct treatment of the intra-cranial disease, we should employ cold to the head, especially by means of Leiter's apparatus, local abstraction of blood, purgatives, sedatives to allay vomiting or pain in the head, subcutaneous injection of morphia for the relief of the severe headache, and in the later stages counter-irritation to the head. It is unnecessary, however, to enter in a very detailed way into the treatment of such affections as cerebral abscess or meningitis, which are fully discussed in general medical and surgical works.

Plebitis, Thrombosis, Embolism, Pyæmia.

The relations of the middle ear to the *lateral sinus*, the first part of the *internal jugular vein*, the *superior petrosal sinus*, and the *internal carotid artery* have been already described (see p. 267).

As is well known, phlebitis and thrombosis are very apt to be set up in the vessels of a tissue which is the seat of suppurative inflammation. The venous channels of the cranial bones and of the dura mater are especially liable to the formation of coagula in their interior. In consequence of this tendency, wounds of the scalp followed by suppurative inflammation are regarded by surgeons as fraught with especial danger. Here in the interior of the temporal bone we have frequently the very conditions, which are liable to give rise to changes within the blood-vessels, of which the formation of thrombi is the initial stage. These conditions are ulceration of the soft parts or of the bone and the presence of decomposing pus and of putrid gases in the immediate neighbourhood of great vascular trunks. The peculiarity of the circulation in the osseous partitions, between the dura mater and the mucous membrane of the middle ear, favours these changes. The blood supply to the bone is derived partly from the dura mater and partly from the mucous membrane, while the venous blood, including that from the *venæ diploicæ*, is discharged partly into the veins of the dura mater and partly into those of the mucous membrane. In these ways free inter-communication takes place in the interior of the bony partitions between the vessels of the dura mater and the mucous membrane of the ear, so that morbid changes in the walls or contents of either set of vessels are pretty sure to be propagated to the other set. Hence, if phlebitis or thrombosis exist in the vessels of the diseased mucous membrane of the middle ear, it is very apt to be propagated by means of the vessels in the interior of the bone to the dura mater or its sinuses, especially to the lateral sinus. Indeed, probably some degree of phlebitis of the lateral sinus is a not unfrequent complication of suppurative disease of the middle ear. The mischief is probably, however, in most cases limited to some thickening of the walls of the sinus, and to a consequent diminution of its lumen. This frequency of the implication of the lateral sinus is due to its anatomical connection with the mastoid cells. In the deep concavity of the groove for the lateral sinus only a thin osseous partition separates the mastoid cells from the walls of the sinus. This partition is always perforated by openings for the passage of connective tissue, vessels, and nerves. It is frequently so thin as to be transparent, and not uncommonly contains small gaps, in which case the mucous lining of the middle ear and the wall of the sinus are in direct contact. While this osseous partition may be eroded and perforated by carious disease (Fig. 110),

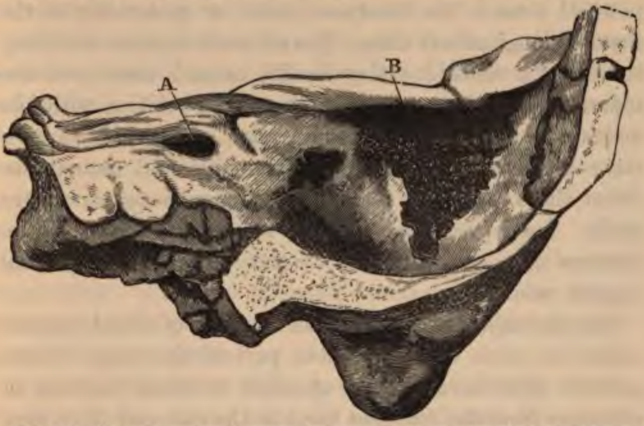

FIG. 110.—Carious erosion of groove for lateral sinus, consequent upon suppurative disease of middle ear. A, internal auditory canal; B, carious disease in situation of right lateral sinus.

affording a ready explanation of the mode of extension of the disease in the ear to the walls of the lateral sinus, the simple juxtaposition of the lateral sinus to the ear is, in suppurative disease, a source of great danger. When, as is frequently the case, the lining of the mastoid cells is chronically inflamed, softened, or eroded, and when these cells are filled with decomposing purulent matter, emitting gases of putrefaction, it is not surprising that phlebitis and thrombosis with their effects should be set up in this large venous trunk, so closely contiguous to, and so connected by blood-vessels with, the diseased part. Small thrombi may be carried inwards from the vessels of the mucous membrane of the ear or of the bones, until they project into the lateral sinus, where fresh formations may take place, until the sinus is filled by a large thrombus. The formation of thrombi may extend from the lateral sinus down the internal jugular vein as far as the superior vena cava. But the coagula may also extend upwards, either anteriorly through the superior petrosal sinus to the cavernous sinus, or posteriorly to the superior longitudinal sinus. The network of veins encircling the internal carotid artery in the carotid canal and the superior petrosal sinus are in immediate relation with the mucous membrane of the tympanum, and may, in suppurative diseases, be involved in phlebitis and thrombosis. From these veins the thrombi may pass to the cavernous sinus. Lastly, from the floor of the tympanum septic influences may pass directly to the bulb of the internal jugular vein.

The thrombi detached by the current of blood become emboli in some near or remote part of the body. These embolic clots have usually attached to them bacteria or vibriones from the purulent focus in the ear, and thus they usually contain the elements of putrefactive changes, giving rise to a fresh purulent centre. In this way septic thrombi swept on by the circulation become the centres of metastatic abscesses in the lungs, kidneys, liver, spleen, joints, or subcutaneous connective tissue. Thus the general mass of the blood may be infected, giving rise to the phenomena of pyæmia or septicæmia. It is suggested by Dr. James A. Adams, of Glasgow, that thrombi with bacteria may be carried to the interior of the brain, giving rise to metastatic abscess there, when the lateral sinus is obstructed or obliterated, by the backward motion of the current of blood. It is also possible that septic inflammation originating in the arterioles of the mucous membrane of the ear may be propagated along the walls of the vessels as far as main arterial trunks, such as the internal carotid, the internal auditory, or the middle meningeal, giving rise to infected coagula, which may be swept along by the blood current, till an embolic purulent centre is formed in the terminal twigs in the brain. It is to be remembered, however, that thrombi, if aseptic, may be absorbed, and do no mischief.

Subjective Symptoms.—The general symptoms of pronounced phlebitis, especially of the lateral sinus, are pretty much those of pyæmia. There are frequently recurring rigors, each followed by high temperature. Headache is, in most cases, present; but it is neither so severe nor so constant as in pure meningitis or cerebral abscess. There is generally also giddiness. The pulse is very rapid. The skin is dry and sometimes yellowish. There is hurried respiration. Delirium is more common than in intracranial purulent processes, while convulsions, paralysis, or coma, are less common.

Objective Symptoms.—The presence of thrombi in the various venous sinuses may, by obstruction to the venous circulation, or by pressure upon certain nerves, excite certain characteristic phenomena.

In thrombosis of the *lateral sinus*, we sometimes find œdematous swelling on the side of the head, in the temporal region, or extending from the mastoid process to the back of the head. This œdema is caused by obstruction to the flow of blood through the emissary veins of the skull. When the *internal jugular vein* is obstructed by a thrombus, the external jugular and the veins of the neck and cheek are at first dilated, with, in some cases, swelling of the cheek and eyelids, owing to the over-distension. After a time this dilatation disappears, from the establishment of a collateral circulation, diverting the blood to the opposite internal jugular. This venous stasis may also produce a colourless swelling, very tender to pressure, on the side of the neck along the inner edge of the sterno-mastoid muscle. In some cases a hard cord is felt by the finger in the course of the internal jugular vein. The pressure of the thrombus upon the nerve trunks passing through the jugular foramen, in company with the internal jugular vein, sometimes produces characteristic symptoms. Various observers have thus reported the existence of phenomena due to irritation or paralysis in the regions supplied by the vagus, glosso-pharyngeal, spinal accessory, or hypoglossal nerve.

The symptoms of thrombus in the *cavernous sinus* may be very numerous and varied, being produced either by stasis of its venous blood or by pressure upon the nerves lying close to the sinus. Stasis of the blood explains the occasional existence in connection with this form of thrombosis of exophthalmos, temporary blindness from œdema of the retina, and swelling of the forehead, eyelids, and nose, while pressure of the thrombus upon the nervus abducens or on the oculo-motor may cause, in the former case, turning in of the eye-ball from paralysis of the external rectus muscle, and, in the latter, ptosis, or drooping of the upper eyelid, and divergent squint.

When the thrombosis extends to the *superior longitudinal sinus*, serious symptoms may arise, such as epileptiform or apoplectic phenomena, probably due to effusion into the cortex of the convexity of the brain from obstruction to the flow of blood through the sinus. In children there may be bleeding from the nose, owing to the fact that in childhood part of the venous blood from the nasal passages is discharged into the superior longitudinal sinus, and the stasis of the venous circulation in the nose caused by obstruction of this sinus leads to hæmorrhage. From the same cause the veins passing in childhood from the anterior fontanelle to the temples and auricle may be dilated and prominent.

Course.—Septic thrombosis may have a rapid course, terminating fatally in a few days by the paralysing influence of blood poison. The course of the disease, however, more frequently extends to two or three weeks, death usually taking place by pyæmia, metastatic abscesses in the lungs, liver, kidneys, or the brain itself.

Diagnosis.—When no objective symptoms of thrombosis of the venous sinus of the head are present, the diagnosis will be somewhat difficult. For a time it may be confounded with typhus or typhoid fever. From meningitis or cerebral abscess it may be often distinguished by the more pronounced rigors in phlebitis, as well as by less disturbance of consciousness and motor power.

Prognosis.—There is no doubt that phlebitis, in connection with suppurative ear disease, leading to thickening of the coats of the vessels and thrombi, especially in the lateral sinus, often exists without a fatal issue. Indeed this is probably a much more frequent complication of ear disease than is usually supposed. Wreden, as the result of his observations, puts the numbers as high as fourteen per cent. of chronic suppurative diseases of the ear. Dusch found that, out of thirty-two cases of thrombosis, twenty originated in purulent disease of the ear. If thrombi exist in the internal jugular vein, or if metastatic abscesses have formed in the brain, lungs, liver, &c., the issue of the case will be almost certainly fatal.

Treatment.—The aural treatment recommended for cerebral abscess and purulent meningitis should be here employed. Large doses of quinine (f. 122) should be given for an antipyretic effect. The further treatment of this condition must be based on general medical principles.

Tubercular Disease.

At a discussion on the pathology of phthisis and tuberculosis held by the Glasgow Pathological Society, in February, 1881, the author ventured to make a suggestion as to a possible source of tubercular infection, to which hitherto but little attention had been directed. The question of the tubercular infection of the system by a virus arising from the softening of caseous deposits, the results of an antecedent inflammatory process, was one of the points most keenly discussed. The frequent coincidence of caseous deposits with miliary tubercles is admitted by all; but even enthusiastic advocates of the doctrine of self-infection have to admit that careful examination of the body after death sometimes fails to discover any such caseous source of infection; and the failure to discover such a focus, even in a few cases, strikes a serious blow at the doctrine of self-infection, as taught in the absolute manner of Buhl, Virchow, Niemeyer and others in Germany, and by Professor Hamilton of Aberdeen in this country.

The mastoid process is a part of the body, almost invariably neglected by the pathological anatomist, where the conditions for the production of caseated products exist probably more frequently than in any other place. We have seen that, in the osseous cavities of the middle ear, catarrhal products are very frequently formed under conditions, which favour, in a remarkable manner, their prolonged retention, stagnation, drying, and caseation. What becomes of these inflammatory products thus confined? Excluding all those cases, in which favourable terminations are happily attained, there is a large number left, in which, if no other fatal complication, such as pyæmia, supervene, the accumulated inflammatory products in course of time inspissate, and become converted into cheesy masses. This change is most likely to take place after the active secreting process has ceased in the seat of the collection. These cheesy masses may remain, and probably often do remain, in the inaccessible parts of the ear for a life-time without provoking any disturbance of the organism. But is it not possible that they may at any time soften, and then, becoming absorbed by the blood-vessels or lymphatics, constitute the virus, which reveals itself in a general tuberculosis or in a local tubercular meningitis?

Just as the presence of decomposing purulent matter does not always produce pyæmia or septicæmia, so the presence of caseous collections in the cavities of the ear may excite tubercular disease only in certain persons or under certain conditions. According to Cohnheim's view, the caseous matter is converted into tubercular matter by the action of certain particles from the air, and then absorbed, just as bacteria from the air acting upon pus convert it into a virus, which, when absorbed, produces septicæmia. In any case, when caseation takes place, the absorption of the caseous matter is more likely to occur in scrofulous individuals. It has been said that tuberculosis is built up almost without exception upon scrofula as a basis, and that scrofula is one of the chief etiological factors in tuberculosis of the pia mater. Probably the absorption of the caseous matter converts scrofula into tuberculosis. Apart from this, we may reasonably conjecture that all conditions or circumstances, which tend to depress the vitality, will add to the danger of these collections, such as bad hygienic conditions, the irritation of dentition, diarrhœa, colds, badly ventilated apartments, improper food especially in infants fed through the bottle. In these circumstances we may suppose that, with cheesy collections in the ear, a child is more exposed to tuberculosis of the pia mater than a child brought up under more propitious circumstances.

The seat of the deposition of tubercle in tubercular meningitis is *very near* to the seat of the caseous centre in the ear. When the infective matter is in the neighbourhood of the tubercular formation, it is usually believed that the medium of absorption and transmission is by the lymphatic vessels. The pia mater is extraordinarily rich in lymphatic vessels, and the tubercular growths are found on the inner surface or endothelium of these vessels. These lymphatic channels surround and enclose the very numerous small arteries, which ramify in the pia mater before they enter the substance of the brain. All the blood-vessels of the brain are accompanied by these lymphatic vessels, or, as they are called, perivascular sheaths. Now, the internal auditory artery, the terminal branch of the basilar, which ramifies in the pia mater, close to the favourite seats of the tubercular deposits, inosculates freely with the stylo-mastoid artery, which furnishes the main arterial supply to the mucous membrane of the middle ear. In this way there is a ready lymphatic connection between the middle ear and the pia mater.

The great richness of the pia mater in lymphatic vessels must render it a likely place for the tubercular deposition. The infective agent carried by the lymphatics, say from the ear, acts as a specific irritant upon the endothelium of the lymphatic vessels, and we have as a result the formation of miliary tubercles. Why does the tubercular formation show a preference for the base of the brain? In the frequency of caseous formations in the middle ears of children, intimately connected with and close to the base of the brain, may we not have an explanation of the otherwise mysterious preference of tubercle for the base of the brain? We know that there is a channel, be it by lymph-vessels or by blood-vessels, by which matter absorbed in the ear may reach the brain, even when healthy tissue intervenes. Practical experience and observation in cases of cerebral abscess consequent upon disease of the ear give too many examples of the possibility of such a means of communication.

Von Tröltsch, of Würzburg, related in Virchow's *Archiv*, so far back as 1859, three cases of acute miliary tuberculosis occurring in persons, who had suffered from chronic purulent disease of the middle ear. At that time he suggested, before he was aware of Buhl's writings on the auto-infection of tubercle, that some cases of tubercular disease might be due to the absorption of inflammatory products collected in the ear. He asks the question, "Whether many cases of suddenly-beginning and rapidly-developing tuberculosis might not generally be due to an infection of the blood from a purulent collection at some part of the body?" It is also remarked by him that, in tracing the history of patients, who have had otorrhœa, he has observed that many of them die young. In such he found that tubercular meningitis, or tuberculosis of the lungs or of the bowels, was generally the cause of death.

No doubt there have been many cases observed, in which tubercular meningitis or acute miliary tubercle occurred in persons, who were suffering from, or had been suffering from, exudative disease of the middle ear. In all such cases, however, it may be fairly urged that the existence of the disease in the ear is a mere coincidence, having no etiological relation to the tubercular disease. Or it may be reasonably maintained that the disease in the ear is a manifestation of the same constitutional tendency, which produced the tubercular disease—that, in fact, instead of being the cause of the tubercular disease, the ear disease is the result of the tubercular tendency in the system.

The presence or absence of caseous collections in the middle ear should be made a point for investigation in the case of persons, who have died from tuberculosis, and especially from tubercular meningitis.*

Hæmorrhage.

Thirteen cases of fatal bleeding from the ear in connection with chronic suppurative disease have been recorded (Hessler). These were all associated with carious disease, either of the osseous partition separating the mucous membrane of the middle ear from the internal carotid artery, or of that separating it from the lateral sinus. The carotid artery is the most frequent source of hæmorrhage, and the perforating ulcer in its walls is generally at the angle formed by the perpendicular and the horizontal parts in the carotid canal. Ulceration of the lateral sinus is much less frequently the cause of the bleeding. The blood escapes chiefly by the external auditory canal; but it may also pass down the Eustachian tube, and escape by the nostrils and mouth. It may also, when coming from the lateral sinus, escape by a carious opening behind the auricle. The blood, in some of the cases, spouted out in a pulsating jet, causing death in a few minutes, and in others it oozed out for hours before the fatal termination. In some again there were repeated bleedings at intervals of from a few minutes to several hours, ending in fatal exhaustion.

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* For a fuller consideration of this subject, see paper read by author at the International Medical Congress, London, 1881, published in the Transactions, vol. iii.

Treatment.—The introduction of astringents, or plugging the external canal, has little or no effect upon the bleeding. Continuous compression of the common carotid, when the hæmorrhage has its source in the internal carotid, should be tried; and, if everything else fails, the propriety of ligaturing the common carotid should be seriously considered. Hitherto that operation has failed in saving life.

PART FOURTH.

DISEASES OF THE AUDITORY NERVE AND LABYRINTH—THE INNER EAR.

CHAPTER I.—ANATOMY AND PHYSIOLOGY.
CHAPTER II.—DISEASES.
CHAPTER III.—TINNITUS AURIUM.
CHAPTER IV.—DEAF-MUTISM.

INTRODUCTORY NOTE.

A CLASSIFICATION of the Diseases of the Inner Ear, based upon clinical facts, is impossible in the present state of our knowledge. Just as the functions of the several parts of the labyrinth are still but imperfectly understood, so our power of distinguishing, during life, the various pathological processes, which may exist in this part of the ear, is very limited. Fortunately with increased knowledge of the pathological anatomy of the ear, and with improvements in the methods of objective examinations, it has been found that diseases *primarily* affecting this section of the organ are much rarer than was formerly believed. In records by the writer of 1088 cases, already referred to, only 48, or 4½ per cent., of the whole were diseases affecting primarily the inner ear. But *secondary* disease of the labyrinth is more frequently met with. When diseases, such as chronic dry catarrh, and chronic suppurative inflammation, have existed for a length of time in the middle ear, the structures of the labyrinth are apt to become at length involved. As we can, therefore, very rarely affirm, merely from the clinical facts of a case, what is the exact pathological condition of the inner ear, or even in what part of the inner ear the lesion is situated, we shall simply discuss the diseases in a general way under the following aspects—1. The most frequent morbid states. 2. The causes giving rise to these. 3. The symptoms manifested by them. 4. Their diagnosis. 5. Their treatment. We shall also in this part take up the subject of *tinnitus aurium*, because, although this may be a symptom of almost any disease of the ear, the most serious and distressing forms are met with in connection with affections of the inner ear. And, as *deaf-mutism* is, in most cases, the consequence of disease or congenital defect in the inner ear, it is taken up under this section of the ear.

CHAPTER I.

ANATOMICAL AND PHYSIOLOGICAL DESCRIPTION.

THE simplest idea of the labyrinth is got from the arrangement found in the lowest fishes, in which there is neither external nor middle ear. The organ of hearing consists, in these creatures, of a simple membranous bag filled with fluid and lined with cells, which receive the terminal fibres of the auditory nerve. These cells have small hair-like processes projecting into the fluid. The sonorous vibrations communicated by the water to the firm parts of the head are propagated to the fluid in the bag, where they impinge upon the minute hair-like processes. The terminations of the auditory nerve are, it is believed, thus stimulated, the stimuli are flashed along the nerve to the brain, and the sensation of hearing is experienced.

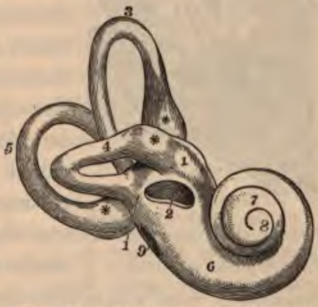

FIG. 111.—Right osseous labyrinth (after Sömmerring) × 2½. 1-1, Vestibule; 2, fenestra ovalis; 3, superior semicircular canal; 4, horizontal or external canal; 5, posterior canal; 6, first turn of the cochlea; 7, second turn; 8, apex; 9, fenestra rotunda; *, ampullae.

Instead of this simple membranous bag we find in man the complicated arrangements of membranous sacs, canals, and tubes forming the *membranous labyrinth* in the vestibule, semicircular canals and cochlea. The membranous labyrinth is contained in an unyielding casing, the *osseous labyrinth*. This consists of spaces, corresponding in shape with the membranous labyrinth, in the petrous part of the temporal bone. These spaces are filled with a watery fluid, in which are suspended the membranous structures. Supposing a metallic cast were made of the cavities, as depicted in the above woodcut, there would be found to be three distinct divisions. There is a central space, named the *vestibule*, which communicates with the tympanic cavity by the fenestra ovalis, closed in the fresh state with membrane, and situated in the inner wall of the tympanum. From one side of this central cavity there spring three arched canals—the *semicircular canals;* while on the opposite side there opens into the vestibule a peculiar spiral tube, which, from its resemblance to the shell of a snail, is called the *cochlea*. The membrane closing the fenestra rotunda separates the interior of the cochlea from the interior of the tympanum. Thus, like the outer and the middle ear, the inner ear is divided into *three* parts, the vestibule, the semicircular canals, and the cochlea. The inner aspect of the osseous wall of the vestibule and the base of the cochlea are pierced with a number of apertures, through which the fibres of the auditory nerve pass from the internal auditory canal to the membranous structures (Fig. 112).

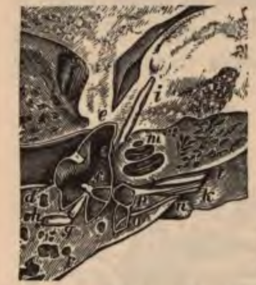

FIG. 112.—Horizontal section through the tympanum and labyrinth, after Rüdinger—*d*, the tympanic membrane; *e*, anterior wall of cavity of tympanum; *f*, stapes with its foot-piece attached to the fenestra ovalis; *g*, stapedius muscle; *h*, a portion of facial nerve; *i*, situation of tensor tympani muscle; *k*, vestibular division, and *l*, cochlear division of auditory nerve in the internal auditory canal; *m*, section of the cochlea; *n*, nerve going to the ampullae; *o*, section of utricle; *p*, section of saccule; *r*, section of a semicircular canal.

The cochlea is the most anterior part of the labyrinth. It has a conical shape, its base being towards the end of the internal auditory canal, and its apex, the *cupola*, towards the osseous part of the Eustachian tube. From the base to near the apex extends a pyramidal pillar, *the modiolus*, which is pierced in the direction of its long axis by canals conveying the fibres of the auditory nerve destined for the cochlea, as well as small blood-vessels. The space between the outer wall of the cochlea and this central part is divided into two winding passages or "staircases," *scalæ*, lying over one another, by a partition which winds in a spiral direction from the base to the apex, *the spiral plate of the cochlea*, and extends between the central pillar and the outer wall. This partition is in part bone and in part membrane. The bony part, springing from the central pillar, reaches half across the interval, while the membranous part completes the other or outer half. This so-called membranous part of the partition is in reality a triangular space—*the membranous canal of the cochlea or scala media*—containing structures of great complexity, bounded above and below by membrane. This partition begins between the fenestra ovalis and fenestra rotunda, and, winding round the central pillar for two turns and a half, terminates near the apex. Of the two winding passages formed in this way the upper is called the staircase of the vestibule, *scala vestibuli*, because it opens directly into the vestibule; and the lower, the staircase of the tympanum, *scala tympani*, because in the macerated bone it passes directly into the tympanum at the fenestra rotunda, although in the recent state it is separated from the tympanum by the membrane closing that opening. These two *scalæ* open the one into the other at the apex by a small aperture, *the helicotrema*. There is a canal of communication, the *aqueductus cochleæ*, between the scala tympani, near the fenestra rotunda, and the interior of the cranium, near the lower margin of the posterior surface of the petrous bone. Many small passages, continuous with the canal in the central pillar, pierce the osseous spiral plate, and convey vessels and nerves to the membranous partition. A membrane composed of connective tissue lines the osseous surfaces of the interior of the labyrinth. This periosteal membrane, lined by a layer of epithelium similar to that of the arachnoid, secretes a thin fluid, *the perilymph*, which fills the two scalæ, and occupies the space between the walls of the osseous labyrinth and the membranous tubes and sacs contained in the vestibule and semi-circular canals. These tubes and sacs may indeed be said to float in the perilymph. This perilymph communicates with the arachnoid space through the aqueductus cochleæ.

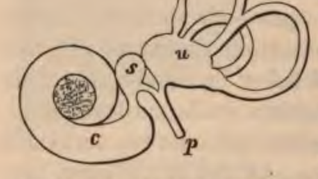

Fig. 113.—Membranous labyrinth (Dr. M'Kendrick)—*u*, utricle communicating with the semicircular canals; *s*, saccule communicating with the membranous canal (*c*); *p*, aqueductus vestibuli.

The *membranous labyrinth* (Fig. 113) is divided into two parts, having a communication with one another. The one consists of the *utricle*, suspended in the perilymph of the vestibule, and three tubes suspended in the perilymph of the three osseous semicircular canals. The three membranous tubes in the semicircular canals are of much smaller calibre than the osseous canals—the latter being fully four times wider than the former. The utricle and the three tubes form one cavity, which is filled with fluid, the *endolymph*. A delicate membranous tube, the *aqueductus vestibuli*, passes from the utricle through a firm osseous canal and terminates in a *cul-de-sac*, covered by dura mater, on the posterior surface of the petrous part of the temporal bone. Each of these three tubes has at one end a bulging, *ampulla*, occupying a similar ampullary widening of the osseous labyrinth. The utricle and each of the three ampullary enlargements of the membranous canals present at one part on the inner surface a thickening, *macula acoustica*, corresponding to the entrance and ramification of the branches of the auditory nerve to these parts. At these thickened parts the *otoconia*, or small crystals of the ear, are found. In the membranous semicircular canals no nerves have been found except at the ampullary widenings.

The second division of the membranous labyrinth consists—1st, of a round bag, the *saccule*, suspended in the perilymph of the vestibule; 2nd, of a long but narrow winding passage, having a triangular shape, *the membranous canal or cochlear duct;* and, 3rd, a very slender tube of communication between the two, the *canalis reuniens*. By means also of another short membranous tube, the saccule communicates with the aqueductus vestibuli (see Fig. 113). The membranous labyrinth thus forms one continuous irregular cavity, filled with endolymph, and surrounded by perilymph. The saccule, like the utricle and each of the membranous semicircular canals, has an enlargement indicating the place of entrance and distribution of the auditory nerve.

In the *membranous canal* (Fig. 114) what is now regarded by physiologists as the most essential part of the terminal apparatus of the auditory nerve is situated, namely, the *organ of Corti*. This canal is situated between the scala vestibuli and the scala tympani. The thin membranous partition, between it and the scala vestibuli, is termed *Reissner's membrane*, and passes obliquely from the upper surface of the osseous spiral lamina to the outer wall of the cochlea, while the partition between this membranous canal and the scala tympani is termed the membranous spiral lamina, or the *basilar membrane*, connecting the edge of the osseous spiral lamina with the outer wall of the cochlea. The organ of

Corti lies on the upper surface of this membrane, inside the membranous canal and immersed in the endolymph. This remarkable structure consists of a double series of rods or fibres, an outer and an inner, arranged on the inner part of the upper surface of the basilar membrane along its whole length. These two series or rows are jointed together at their upper ends so as to form an arch. There are more of the rods in the inner row than in the outer, so that three of the inner rods are sometimes attached to two of the outer. In the human cochlea there are supposed to be 3000 of the outer rods, and still more of the inner rods. They gradually diminish in length towards the upper part of the cochlea. External to the outer row of Corti's rods there are several rows of elongated cells (Corti's cells), resting by their lower ends on the upper surface of the basilar membrane, while their upper extremities are furnished with fine hairs projecting into the endolymph. Inside of the inner row of Corti's pillars another row of these cells is found, also furnished with hairs. It has been shown by Waldeyer

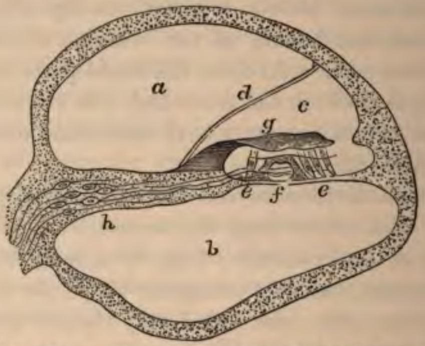

FIG. 114.—Cross-section of the cochlea (Landois)—*a*, scala vestibuli; *b*, scala tympani; *c*, membranous canal, or cochlear duct; *d*, Reissner's membrane; *e e*, Corti's cells, and *f*, Corti's rods, both resting on the basilar membrane; *g*, Corti's membrane; *h*, osseous spiral lamina.

and Gottstein that these cells are in connection with the ends of the fibres of the cochlear nerve, which, branching from the nerves passing through the central pillar of the cochlea, reach Corti's cells by delicate cross canals in the osseous spiral lamina.

The *auditory nerve* has its origin at the back part of the medulla oblongata in the floor of the fourth ventricle. While the arrangement of the roots is still a subject of investigation, it is so far made out that they are connected with the grey matter of the cerebellum, the floor of the fourth ventricle, the restiform body, and the lower border of the pons. The researches of Ferrier seem to show that the temporal lobe of the cerebrum of the opposite side contains a centre of the auditory nerve, and that the fibres of the nerve decussate in their course from that centre to the ear. Destruction of the temporal lobe caused total loss of hearing on the opposite side. No fibres of the auditory nerve can, however, be traced to the temporal lobe.

From the medulla to the inner end of the internal auditory canal the auditory nerve is in contact with the facial nerve, and in that canal they are connected by one or two filaments. A small artery destined for the labyrinth usually lies between them. In the internal auditory canal the nerve divides into two sets of fibres. One set, the cochlear, pierces the front of the cribriform lamina below the opening of the aqueduct of Fallopius, and ascends in small canals through the centre of the modiolus, branching off through the osseous spiral lamina to end in Corti's hair-cells in the membranous canal. The fibres forming the other set—the vestibular nerve—pierce the back part of the cribriform lamina, and pass to the ampullæ of the membranous semicircular canals and to the utricle, where the nerve fibres terminate in cells with small hairs, which project into the endolymph.

Sonorous vibrations are conducted to the fluid in the labyrinth in two ways. 1st, By the special sound-conducting apparatus provided in man and in all air-breathing animals —this is sometimes called "air conduction of sound"; and, 2nd, By the bones of the head either from direct contact of the vibrating body, direct osseous conduction, or by the waves of sound reaching the surface of the head through the air, indirect osseous conduction.

The first is the ordinary mode of hearing in man. The waves of sound originating in a vibrating body are transmitted through the medium of the air to the tympanic membrane, the vibrations of which are conducted mainly through the malleus, incus, and stapes to the perilymph of the vestibule, but also partially through the air in the tympanic cavity to the perilymph in the scala tympani through the membrane closing the fenestra rotunda.

By the vibrations of the stapes the fluid of the labyrinth is put into a state of oscillation. The minute wavelets, thus set in motion, stream through the spaces and passages of the labyrinth. Multitudes of little taps or blows impinge upon the terminal structures of the auditory nerve in the various parts of the membranous labyrinth, some kind of change is thus produced in the nerve, which is at once conveyed to the brain, and in a way unknown to us these purely physical movements of matter are transformed into that sensation, which we designate sound.

An inward movement of the base of the stapes produces an outward movement of the membrane of the fenestra rotunda; the displacement of fluid passes along the scala vestibuli of the cochlea through the helicotrema to the scala tympani, at the end of which it presses upon the membrane of the fenestra rotunda, which then bulges towards the tympanic cavity. On the other hand, in every movement of the stapes outwards this membrane sinks into the scala tympani. It is thus easy to see that thickening or rigidity of the membrane of the fenestra rotunda must have a disturbing influence upon the vibratile movements of the labyrinthine fluid. Through the aqueductus cochleæ the perilymphatic space is connected with the subarachnoid space, and the perilymph, if exposed to great pressure, may be forced into the subarachnoid space, or, on the other hand, excessive pressure on the cerebro-spinal fluid may force it into the labyrinth. In the former case injury to the delicate nerve structure by excessive pressure may be averted, while in the latter way morbid conditions of the subarachnoid space may be communicated to the labyrinth.

The special function belonging to each of the three divisions of the inner ear is still a matter of uncertainty. The view that the *vestibule* is specially intended for the perception of noises as distinguished from musical tones has been refuted by the experiments of Ranke and Hensen, and is no longer held by physiologists. The function of the *semicircular canals* has been the subject of very great inquiry by many and able experimenters, who are, however, not agreed. From the peculiar relation of the one semicircular canal to the other, being placed at right angles to one another, it has been supposed by some physiologists that they are connected with the faculty of distinguishing the direction of sound. The hypothesis, however, which has provoked the greatest discussion, is that, which ascribes to this part of the labyrinth the centre of that power, by which the movements of the muscles of the body are so co-ordinated, as to enable us to maintain the upright position. This view originated in experiments of Flourens, who found, after severing the semicircular canals in the pigeon and rabbit, that peculiar rotatory movements were executed by the animals. Goltz, Mach, Crum-Brown, &c., confirmed by experiments the results obtained by Flourens, and the view seemed to be fairly established that the semicircular canals were the "static organ" of the body, and had nothing to do with hearing. Other eminent experimenters, however, such as Böttcher, Baginsky, and Moos, alleged that these peculiar movements were due to injury inflicted on the cerebellum by the manipulations necessary in performing the vivisection. It has been found more recently that simple injury to the canals without division is followed by motor disturbance, while the complete destruction or severance of the membranous semicircular canals does not produce that effect.

The view most generally accepted at present is that some nervous connection exists between those fibres of the auditory nerve, which go to the ampullæ and vestibule, and certain parts of the cerebellum; and that, when these become irritated or injured, a reflex effect is produced on the cerebellum, expressing itself in disturbances of the equilibrium of the body. We shall see afterwards the bearing of this upon the cause of *giddiness* as a symptom of certain forms of ear disease.

Physiologists are generally agreed that the *cochlea* is the most important and most highly developed part of the labyrinth. According to the most generally accepted theory of hearing the terminal apparatus of the cochlear nerve has for its function the recognition and analysis of musical tones. Hensen, supported by Helmholtz, believes that the fibres of the basilar membrane, which are in connection with the ends of the nerve through Corti's cells, may be regarded as a vast number of stretched strings of all lengths, and that only those of them are set into vibration, which correspond with the particular tone or number of vibrations, which at the moment enters the ear. In this way long fibres vibrate in unison with low tones, and short fibres with high tones.

CHAPTER II.

DISEASES OF THE INNER EAR.

1. Pathology.

TOYNBEE, Voltolini, Kramer, and other observers have done a great deal in laying before us the coarser pathological anatomy of the inner ear. Less has been done in the direction of elucidating the finer or microscopic changes in the blood-vessels and nerves. The most frequent pathological changes, which many sections of the inner ear have shown to exist, are the following :—

1. *Changes in the Labyrinth.*—Hyperæmia, acute purulent inflammation, anæmia, extravasations of blood or serum, thickening of the membranes of the labyrinth, atrophy of the same, pigmentary collections, defect or excess of otoliths, defective formation of semi-circular canals, vestibule, or cochlea, absence of fenestral openings, fibro-muscular tumours, cholesteatomatous masses, caries or necrosis of the walls of the labyrinth, exostosis of the osseous walls.

2. *Changes in the root, stem, or terminal branches of the auditory nerve.*—Atrophy, due either to the pressure of tumours such as sarcomatous, cancerous, or tuberculous masses, or to defective nourishment of the nerve, or to disease in the cerebellum or medulla at the root of the nerve; inflammatory softening extending from the labyrinth or meninges, calcareous change, fibrous degeneration of sheath, fatty metamorphosis, pigmentary deposition, formation of

corpora amylacea, pathological conditions of the central nervous system, involving the acoustic centre or stem of the nerve, such as apoplectic clot, softening of the brain substance, cerebral abscess, tubercular deposition, inflammation of brain or meninges.

2. Causes.

The causes are very varied, and may affect the inner ear from the direction either of the cranium or of the external and middle ear; from abnormal states of the constitution or of the blood; from reflex vaso-motor connection with near or remote parts of the body; or, lastly, from injuries.

1. *Morbid intra-cranial conditions* frequently exert an injurious influence upon the labyrinth or auditory nerve. The nutrient artery of the labyrinth, the internal auditory from the basilar, is really a brain artery. Hence, disturbances in the vaso-motor control of the arterial system of the brain or meninges are likely also to involve the vessels of the labyrinth. So, a narrowing or closure of the internal auditory artery or of the basilar, from pressure or other cause, may result in an anæmic condition of the labyrinth. Aneurism of either of these vessels will also affect the circulation of the labyrinth. Atheromatous conditions of the arteries of the labyrinth are also usually associated with atheroma of the vessels of the brain. Hæmorrhage into the labyrinth may take place from this cause. Again, the veins of the labyrinth discharge their contents chiefly into the superior petrosal sinus of the dura mater. Hence, any obstruction of this venous channel or of any of the large venous channels passing out of the interior of the cranium may lead to a passive congestion of the vessels of the labyrinth. Further, the acoustic centre, or stem of the nerve may be affected by pathological conditions in or acting upon

the brain, such as apoplectic conditions, inflammation of the brain or meninges, tumours in the brain, or abscesses in the brain. In these cases the nerve at its centre or in its course is either pressed upon, or shares in the pathological process. Epidemic cerebro-spinal meningitis seems to be not unfrequently attended or followed by complication in the labyrinth or auditory nerve. Observers of this disease report that persons, who recover, often suffer afterwards from total deafness. In the somewhat limited number of sections of the ear, which have been made after death from this disease, changes have been found in some cases in the root of the nerve, and in others in the vestibule and semicircular canals. In some cases the labyrinth and tympanic cavity were found to be filled with purulent matter. The aqueducts of the vestibule and cochlea are also channels, by which morbid processes in the interior of the cranium may be propagated to the interior of the labyrinth.

2. *Diseases of the external, or more frequently of the middle ear*, may originate morbid conditions of the labyrinth, either of a temporary or permanent character. Congestive or inflammatory conditions of these sections of the ear are often associated with hyperæmia, and even serous exudation, in the labyrinth. The hyperæmia in the latter region may be due in these cases to vaso-motor reflex influence, but probably more frequently to direct vascular connection. The stylo-mastoid artery provides the chief arterial supply to the tympanic cavity, and also gives a few twigs to the labyrinth, while it inosculates with branches of the internal auditory artery. These hyperæmic conditions of the labyrinth, which may co-exist with congestive conditions of the external or middle ear, are usually temporary, and pass off with the disappearance of the peripheral inflammation. Probably, however, there is sometimes extravasation of blood from the dilated vessels, or serous exudation,

or even inflammation with thickening of the labyrinthine membranes may result. The inflammatory changes, which take place in the mucous lining of the fenestral structures in chronic catarrh, especially the sclerotic form, frequently extend to the membranous and nervous structures of the labyrinth. Acute inflammation, with purulent formation, sometimes occurs, owing to caries of the labyrinthine wall of the tympanum. Caries or necrosis of the osseous walls of the labyrinth is usually due to extension of purulent disease from the middle ear. Such extension is facilitated by the numerous spaces in the bone surrounding the labyrinth, which are in communication with the mastoid cells. Several cases are known of the whole or a part of the osseous labyrinth being exfoliated through the external auditory canal or mastoid process.

Probably the most important cause of labyrinthine disease, acting from the direction of the middle ear, is *excessive pressure upon the fluid of the labyrinth.* This excessive pressure is exerted through the fenestral membranes, chiefly through the fenestra ovalis, and may be produced both by acute and chronic diseases of the middle and external ear. This pressure may be due (1) to the foot-piece of the stapes being forced in upon the fluid of the labyrinth; (2) to collections of secretion lying upon the inner wall of the tympanum, and pressing upon the fenestral structures; or (3) to thickening of the membrane of the fenestra rotunda or annular ligament of the base of the stapes. When we consider that the labyrinthine fluid is contained in a cavity with unyielding walls, except at the fenestral openings, and having no means of exit except through the two very slender aqueducts, it is easy to see that, if exposed to pressure at one of the fenestral openings, especially if the membrane closing the other opening is rigid, the delicate terminal structures of the auditory nerve must suffer. There is little doubt that, if this pressure is continued for a great length of time, permanent changes of the structures exposed to it must ensue. Probably sudden and great pressure produces greater functional injury than gradually increasing pressure.

We have to add that, when a high degree of defective hearing, due to an affection of some part of the external and middle ear, has existed for a long time, the terminal structures of the auditory nerve are liable to become atrophied from the absence of the specific nerve stimulation. Still it is frequently found that such a form of deafness may continue for a very long period without injury to the nerve, as shown by ultimate complete restoration of hearing.

3. *Certain general diseases or changes, which involve the circulation,* influence injuriously the labyrinth. The zymotic diseases, especially scarlet fever, typhoid fever, and typhus fever, are not unfrequently attended by disturbance of the auditory function without apparent disease of the external and middle ear. It is probable that these disturbances are due to hyperæmic conditions of the labyrinth, which in many cases pass off during convalescence from the general disease, but which sometimes lead to permanent mischief, shown by the persistence of the deafness or subjective sounds in the ear.

A number of medicinal substances seem to exercise a disturbing influence upon the labyrinthine circulation, manifesting itself by deafness, or by singing or other sounds in the ear. The chief of these substances are quinine, salicine, salicylate of soda, opium, morphia, and alcohol. Large doses of these are usually necessary to produce the effect on the ear, but with persons, who suffer already from defective hearing, even ordinary doses may aggravate the aural disturbance, and this aggravation may remain permanent.

Degenerative diseases of the kidneys and liver by their effect on the blood may give rise to changes in the labyrinth, especially in persons predisposed to ear disease.

Anæmia, due either to disease or to rapid loss of blood, may, by the local anæmic state of the labyrinth, cause deafness and noises in the ear. The ringing in the ear, which often accompanies post-partum flooding, is an example of the effect of rapid loss of blood.

Some cases of mumps seem to be associated with sudden and extreme deafness, of a permanent character, owing to changes as yet unknown occurring in the interior of the labyrinth.

Unquestionably, however, the most important constitutional disease, which may give rise to disease in the labyrinth, is *Syphilis.* Syphilis of the labyrinth may manifest itself during the secondary period, but more frequently in the tertiary period, perhaps many years after the primary disease. In some cases no other symptom of syphilitic disease is present. An affection of the labyrinth is not unfrequently met with in children suffering at the same time from keratitis or iritis due to hereditary syphilis.

4. *Injuries of the ear or head* are very common causes of disease in the labyrinth or auditory nerve. Such injuries may be due to (*a*) blows or falls upon the head; (*b*) sudden and extremely loud noises, such as the report of a cannon or rifle close to the ear, especially if in an enclosed space; (*c*) less intense noises continued over a long period of time, as in the case of men employed in a boiler work or in riveting. These causes frequently lead to serious and permanent changes in the organ of hearing. A blow or fall upon the head may, either with or without fracture of the petrous bone, rupture the tissue in the interior of the labyrinth, with effusion of blood, and produce great and permanent damage to the delicate terminal structures of theauditory nerve, or there may be tearing of the nerve in

its stem or at the roots in the brain. The injury may, without fracturing the bone or tearing the soft parts, cause violent concussion or shaking of the delicate structures of the labyrinth or of the nerve, setting up violent irritation of the terminal nerve structures or paralysis of their perceptive power. Chronic inflammatory thickening of the membranous labyrinth may be the issue of such a concussion. In these severe injuries, due to fracture or simple concussion, the effects are generally not confined to the labyrinth, but involve also the middle ear, in which there may be dislocation of the *ossicula* or rupture of the soft parts with effusion of blood into the cavity of the middle ear, and subsequent inflammatory reaction.

When the injury is more indirect in its nature, such as from loud noises or great condensation of the air in the external auditory canal, as from a blow on the ear, the mischief in the labyrinth consists in either paralysing or severely irritating the endings of the auditory nerve. It is found that, if the force exerted by the compression of air is partially spent in rupturing or injuring any of the tympanic structures, the labyrinth either escapes altogether or sustains less injury, than when the middle ear has not received damage. The effects of injuries to the labyrinth are usually also much more severe, if any disease has previously existed.

In cases of deafness and noises in the ear from the effects of loud and continued noises, as in the case of boilermakers, blacksmiths, &c., it is supposed by some writers that the symptoms may be due to a tonic contraction of the tensor tympani muscle, producing a permanent thrusting inwards of the stapes upon the fluid of the labyrinth. It is well known that a loud noise in the neighbourhood of our ears has not so injurious an effect, if we are prepared for it. It is alleged that, when a loud noise is expected, the tensor tympani muscle contracts, causing a tightening of the tympanic membrane and ossicular chain. This forces the base of the stapes inwards on the fluid of the labyrinth, but at the same time damps the power of vibration of the ossicular chain, and lessens the effects of the intense sonorous vibrations upon the fluid of the labyrinth and ends of the auditory nerve. Such an action of the tensor tympani going on constantly for years may produce a permanently indrawn position of the base of the stapes and an abnormal pressure on the fluid of the labyrinth.

5. *Reflected vaso-motor impressions* probably sometimes bring about congestive conditions of the labyrinth, manifesting themselves in partial deafness and sounding in the ear, generally temporary in character. The vaso-motor connections of the labyrinth are wide and numerous. The effects of disturbance of the digestive process upon the ear may be explained from such a connection. The aggravation, which is often noticed in an aural affection during menstruation, pregnancy and lactation, is pretty often to be accounted for in like manner. So also the deafness and noises in the ear, usually of a very fluctuating character, which are associated with some forms of hysteria, are probably due to reflex disturbance of the circulation in the labyrinth.

3. Symptoms.

Disease of the labyrinth or auditory nerve manifests itself by one or more of the following symptoms—1. Deafness, which is usually severe. 2. Subjective sounds in the ear. 3. Giddiness or staggering gait. 4. Nausea or vomiting. A typical example of primary labyrinthine disease is known by the name of *Ménière's disease.* Ménière in 1861 described a series of symptoms, which he held to be due to a pathological condition in the semicircular canals. These symptoms consisted in a sudden attack of giddiness or staggering, causing the person to fall to the ground, or to turn or wheel to one side. Nausea or vomiting, and at times fainting, were sometimes present, but rarely unconsciousness. At the moment of the attack, or immediately after, deafness, usually very decided, is experienced on one or both sides along with great noises in the ear. In some cases there is great pallor of the face, with cold sweatings. The suddenness of the attack and the character of the symptoms may give rise to the suspicion of a sudden mischief in the brain. And as in point of fact it may be due to sudden hæmorrhage into the labyrinth, it is designated by Knapp *apoplectiform deafness.* It is said to be sometimes preceded by an *aura*, consisting of a sounding in the ear. The attack may take place in a person previously free from any affection of the ear, or in one, who has already had some affection of the middle ear, especially chronic dry catarrh.

In many cases the deafness and noises in the ear prove permanent, while the other symptoms pass off after a period varying from a few minutes to several days. A greater or less tendency to stagger often continues for a time, with some giddiness. Frequently, however, after an interval of variable duration, a renewed seizure takes place, followed by another interval, and these may continue for years. Usually after each attack the deafness becomes more and more profound. It has been observed in some cases that, when a state of complete and permanent deafness had been reached, the attacks ceased to occur.

Ménière based his opinion as to the pathological seat of the disease—1st, On the examination, after death, of the head and ears in a case, which presented in a marked form the symptoms just described. In this case, while he found no lesion in the brain or interior of the cranium, the semicircular canals were occupied by reddish lymph. 2nd, On the theory of the special function of the semicircular canals, which ascribes to this part of the ear the function of controlling the equilibrium of the body.

The view, which is now pretty generally entertained by aural surgeons, is that the term Ménière's disease should only be applied to those cases, in which the symptoms come on suddenly in a person previously in good health and with normal hearing, and in which, on examining the ear very soon afterwards, no evidence of disease is found in the external or middle ear. The strong presumption in such a case is that, if there is no disturbance of any of the cerebral or spinal nerves, we have to do with a sudden pathological change in the interior of the labyrinth, probably an effusion of blood or an exudation of lymph, in such a position as to press upon and irritate the vestibular and ampullary nerves.

But the whole series of symptoms included in the term Ménière's disease may be called forth by diseased processes in the middle ear, such as rapid and great effusion into the cavity of the tympanum, producing great pressure upon the fluid of the labyrinth through the fenestral membranes. If, as is probably the case, there are nerves in the ampullæ or vestibule, the irritation of whose fibres transmitted to some centre in the brain produces giddiness and other disturbance of the equilibrium, any kind of pressure acting upon the fluid of the labyrinth, if sudden and severe, may excite this irritation, culminating in a seizure of Ménière's disease.

While *injuries* of the labyrinth, if slight, may produce no more severe symptoms than a singing or ringing in the ear, passing off after a time, they may, when severe, excite extreme deafness, great tinnitus, and perhaps giddiness with vomiting. The deafness and noises frequently remain permanent and incurable.

Syphilis of the labyrinth is usually characterized by extreme deafness, by great subjective noises in the ear, and sometimes by giddiness (Ménière's series of symptoms), with diminution or total abolition of the perception of sound by osseous conduction. These symptoms frequently come on very suddenly, and the disease usually affects both ears, although it is sometimes limited to one ear for months, when the other may also become affected. It may occur in a person, whose ears have been previously quite normal; but we frequently find that catarrhal disease of the middle ear, originating often before the syphilitic disease affected the system, though not of an extreme form, has existed previously. Suddenly, often in a night's time, the syphilitic poison attacks the labyrinth, and the moderate deafness, previously due to the catarrhal affection, becomes almost total, and attended by distressing noises in the ear. It has been noticed by several observers that in the syphilitic constitution an injury to the head seems to precipitate the affection of the labyrinth. Sometimes, again, we find that, while a fresh catarrh evidently exists in the middle ear, the extreme character of the deafness and the indications derived from the state of the osseous conduction raise the suspicion that the catarrhal affection is complicated with mischief in the labyrinth.

Giddiness, or the so-called *auditory vertigo,* is frequently complained of by persons suffering from ear disease. While it is usually associated with deafness and noises in the ear, the condition differs from Ménière's disease proper either in the seizures being much milder, or in the fact of deafness or other symptoms of aural disease having previously existed. There may have been a history of a well marked seizure at one time, and since the attack occasional giddiness, staggering, or unsteady gait. There may be at intervals of months more marked attacks of vertigo with a sense of going round or backwards and forwards, and at other times slighter sensatoins of giddiness. During the more distinct attacks the deafness and tinnitus are often said to be worse. It is now generally recognised that *giddiness may exist with almost any form of disease of the ear.* We have already drawn attention to the fact that the labyrinthine fluid may be exposed to pressure from the direction of the middle ear through the fenestral openings. Accumulation of secretion, polypi, thickened mucous membrane, especially that lining the fenestral structures, undue pressure inwards of the ossicular chain—these may produce sudden or gradual pressure upon the fluid in the labyrinth, calling forth sudden severe giddiness, or milder forms of it. But, judging from clinical experience, the irritation of nerves in both the external and middle ear may in certain cases give rise to giddiness. Unpleasant effects in some patients follow gentle syringing, or the most cautious manipulation of the ear, when giddiness may be excited, so severe that the patient falls to the floor. This may be due to a reflex connection with the semicircular canals; but more probably, the writer believes, to a reflex irritation of the cerebellum. There is no doubt that from the ear a reflected influence may be exerted upon the cerebellum, giving rise to cerebellar phenomena. When an ear disease exists along with symptoms of cerebellar disturbance or injury, it may be impossible to say whether the lesion is a primary one of the cerebellum or reflected from the semicircular canals or middle or external ear.

As a rule the *deafness* associated with disease of the labyrinth or nerve is much more extreme than in disease of the conducting apparatus, and is not confined to the ordinary mode of hearing by aerial conduction, but involves also perception by osseous conduction. From the mere intensity of the deafness, however, it is not possible to distinguish a lesion of the labyrinth or nerve. Very great deafness may exist in consequence of complete rigidity of the stapes and fenestral structures; but in this case it has usually advanced slowly and gradually. On the other hand, in disease of the labyrinth or auditory nerve the great deafness usually comes on suddenly or progresses very rapidly.

In persons suffering from an affection of the labyrinth there is sometimes noticed a *want of perception of particular tones*, while the perception of others may be normal. This is usually looked upon as evidence of disease of the cochlea. But partial tone-deafness may be due also to changes in the tension of the tympanic membrane and ossicular chain, and it is sometimes noticed in perforation of the tympanic membrane. If this partial tone-deafness is not connected with disease of the conducting apparatus, the anomaly is probably due to cochlear disturbance, and the seat of this, if Helmholtz's theory of hearing is the true one, must be in the basilar membrane.

Even in persons, whose hearing may be looked upon as normal, the power of hearing the highest tones, such as the chirping of a cricket, may be defective or quite absent. Such peculiarities also as comparatively defective hearing for musical tones, or for noises, or for spoken words, are probably connected with cochlear disease.

We occasionally find that the ear interprets the tone incorrectly—instead of the real tone proceeding from the sounding body being heard, a sound may be appreciated, which is a half tone, a complete tone, a third, or an octave higher or lower. This is *paracusis* or false hearing. If only one ear is affected, we have the phenomenon of *paracusis duplicata*, a double tone is heard, namely, the true one on the normal side and the false one on the affected side. In these various anomalies of hearing, particular fibres or groups of fibres of the basilar membrane are in some way disturbed. The assumption is that a morbid condition of the longer fibres disturbs the correct perception of the low tones (bass deafness), while an abnormal condition of the short fibres impairs or destroys the power of correctly recognising high tones. In the hearing of a double tone, *paracusis duplicata*, probably the fibres of the basilar membrane on the two sides corresponding with each other do not vibrate co-equally in number. Thus, supposing the sounding object vibrates 600 times in the second, the fibres on the normal side, which are in exact unison, vibrate that number of times, while the corresponding ones on the opposite side from some defect vibrate say 450 times in a second. Another form of peculiarity is sometimes met with in the perception of tones, namely, the perception of the same tone twice over, or the hearing of a tone for a short period after the objective sound has ceased.

Extreme sensitiveness to sound, *hyperæsthesia acoustica*, occurs in a variety of circumstances. In fevers, in the early stage of inflammation of the middle ear, in hysteria, in migraine, in persons who sleep lightly, or with overstrained nervous system, for a short time after the removal of a plug of cerumen, which had caused great deafness, there is sometimes an unpleasant or even painful perception of sound, which may be limited to particular notes. Even in persons, who may be very deaf, loud sound, such as speaking through a conversation tube, is sometimes very disagreeable.

4. Diagnosis.

Are we able to discriminate, in abnormal conditions of the organ of hearing, disease of the labyrinth and auditory nerve from disease of the conducting apparatus? Is the disturbed function of the organ due to a hindrance to the transmission of the sound from the exterior to the terminal nerve structures, or is it due to pathological changes in the nerve itself, either at its origin, in its course, or at its terminations in the labyrinth ? These are questions involving the prospects of a case of disease in the auditory apparatus, and, even in general medical diagnosis, their consideration is often demanded, when disturbance of the function of hearing or some form of tinnitus aurium is one of the symptoms present.

In this inquiry, tests applied to determine the acuteness of the perception of sound conducted by the bones of the head are of the very greatest importance. The student is referred to Part First, page 31, for further details on this subject.

We must here distinguish two groups of cases—first, those in which examination by the external auditory canal and Eustachian tube shows little or no departure from health ; second, those in which such an examination gives distinct evidence of disease in the external or middle ear.

First, Cases in which careful examination of the external and middle ear *yields negative results*. If a loudly ticking watch placed in contact with the bones of the head is not heard at all, we may suspect an affection of the nerve ; this suspicion is still greater, if Politzer's acumeter, when applied to the bones of the head, is not perceived by the patient. If the vibrating tuning-fork applied to the vertex is not heard at all, or for a very short time, and if, after it has ceased to be heard at the vertex, it is heard when held close to the ear (aerial conduction), there is very great probability that there is disease of the labyrinth. The probability of a labyrinthine disease, or of a disease of the auditory nerve, is confirmed, if the patient is afflicted not only with a high degree of deafness, but also with great subjective sounds in the ear, and especially if the deafness and subjective noises have come on suddenly, with loss or marked diminution of the perception of sound by osseous conduction. It is also to be noted that sudden labyrinthine disease generally involves both ears, and that the most common causes are constitutional syphilis, injuries to the head, sudden and loud noises, and apoplectic or meningeal affections of the interior of the cranium.

On the other hand, if, after a long period of gradually increasing deafness, examination of the external and middle ear yields negative results, and if the tuning-fork by osseous conduction is distinctly heard, or, the affection being confined to one side, is heard better on the affected side, the probability is that the disease is in the conducting part of the ear, and that there is anchylosis of the stapes or thickening of the fenestral membranes. This is confirmed, if, after the tuning-fork has ceased to be heard near to the ear by aerial conduction, it is heard for some time, when transferred to the mastoid process or vertex. It must not be forgotten that important changes may exist in the fenestral membranes, or in the recesses leading to them, which cannot be recognised either by ocular inspection or by any other objective mode of examination.

Second, Examination may show a *decided affection of the middle ear*, and in consequence of secondary disease in the labyrinth there may be diminished perception by osseous conduction. The affection is in the great majority of cases confined to the conducting apparatus, if the sound by osseous conduction be heard distinctly louder on the affected or worse side; or, both sides being equally affected, if the tuning-fork be heard as long as on our own persons—our own auditory nerves being healthy. On the other hand, secondary disease of the nerve is probably present, if we have an affection of the middle ear, which has existed during a very long period, perhaps from childhood, with very great deafness, while the sound by osseous conduction is heard better on the normal or better side, especially if we have had the opportunity of tracing the course of the disease, and have noticed gradually increasing difficulty of hearing with gradually diminishing perception of the tuning-fork on the head. Or again, if a person, who has suffered from catarrhal disease of the middle ear, with only moderate deafness, becomes suddenly very much worse, with great noises in the ear and diminished osseous conduction, there is great probability of a labyrinthine complication. In short, the failure to hear the vibrations of the tuning-fork by osseous conduction, in chronic affections of the tympanum, especially if the deafness is increasing and attended by great noises in the ear, is presumptive of the existence of secondary disease of the nerve.

5. Treatment.

The treatment of disease of the labyrinth and auditory nerve depends upon the cause, if we are able to recognise it.

Probably the most clearly defined condition is due to syphilis. Unfortunately, the satisfactory results, which usually attend the treatment of this disease in most other regions of the body, are not achieved in syphilitic affections of the labyrinth, although they are probably more satisfactory than in many of the other labyrinthine diseases. In the more recent forms of the disease the treatment is more successful than in those of very long standing. Iodide of potassium, in very large doses (f. 100), is on the whole probably the most satisfactory method of treatment. Inunction of half a drachm of mercurial ointment every day into the armpits and inside of the thighs, varying the place in order to avoid irritating the skin too much, succeeds in some cases, where the iodide of potassium fails. Ointment of iodoform or mercury (f. 21 and 22), rubbed behind the ear over the mastoid process, may also be applied. Politzer recommends the subcutaneous injection, in recent cases, of a solution of muriate of pilocarpine (f. 89). The injection of an aqueous solution of iodide of potassium, five grains to an ounce of water, through the catheter into the cavity of the tympanum, every second day for two or three weeks, is supposed by some to assist the absorption of syphilitic products in the interior of the labyrinth.

In the treatment of a distinct Ménière's attack, only soothing treatment is applicable for the first two or three weeks—*i.e.*, rest in bed with the head elevated, bathing of the feet and legs in hot water with mustard, mustard-plaster to the nape of the neck, derivatives by the bowels, and light digestible diet. Politzer recommends here also subcutaneous injection of a solution of muriate of pilocarpine. After a few weeks large doses of quinine, to the extent of fourteen to twenty grains per day, should be tried for the giddiness and noises in the ear, if these continue. It is to be remembered that small doses of quinine may aggravate these symptoms, while large doses may have a decidedly beneficial effect. If quinine does not prove beneficial, iodide of potassium, eight grains three times a day for several weeks, should be used. Counter-irritants to the back of the ear, such as the ointment of iodide of potassium or tincture of iodine, may in the later stages be applied. At the same stage, if the foregoing remedies are ineffectual, electricity in the form of the continuous current should have a fair trial, extending over two or three weeks (see p. 122).

When subjective noises in the head seem to be the chief cause of distress, large doses of bromide of potassium may be beneficial (f. 120). In cases where giddiness is a marked feature, the rarefaction of the air in the external auditory canal may sometimes be employed, especially if the membrane is indrawn, although it may alleviate the giddiness, even when the tympanic membrane is normal in position. Incising a prominent posterior fold has had, in the hands of Politzer, a good effect on giddiness due to ear disease.

If we suspect that there is recent *hyperæmia* of the labyrinth, local blood-letting over the mastoid region would be a reasonable procedure. We know that the stylo-mastoid artery, which supplies the soft parts over the mastoid process, inosculates freely with the internal auditory artery in the tympanic cavity, and in this way a distinct vascular connection is brought about between the labyrinth and the external parts. When hyperæmia of the labyrinth is associated with cerebral congestion, cold to the head, purgatives, and the usual treatment of cerebral congestion must be employed.

In *anæmia* the general treatment suitable for that state should be employed in addition to the more special treatment already spokėn off. Country air, plenty of nutritious and digestible food, and suitable preparations of iron (f. 91 to 97) are appropriate.

Vesication over the mastoid process by means of cantharides is more likely to be serviceable in labyrinthine disease than in disease of the middle ear. When the symptoms prove persistent, vesication behind the ear repeated three or four times may be tried, and is sometimes advantageous.

In all forms of labyrinthine disease constipation must be avoided. Mineral waters such as Hunyadi János, Püllna, or Friedrichshall bitter water (f. 110), are frequently useful in allaying the subjective sounds in the ear. Proper diet, extremely sparing use of alcohol and tobacco, and plenty of fresh air, are of great importance both as preventive and remedial measures.

The constant galvanic current (see p. 122) is frequently employed in affections of the labyrinth, and especially of the auditory nerve. The most diverse opinions are held by aural surgeons regarding its value. It should not be employed in the acute forms of disease, but rather when we suspect a torpid or paralytic condition of the auditory nerve, as shown by simple defect of hearing without subjective noises, and not due to disease of the outer or middle ear. In order that this treatment may have a fair chance, there should be at least ten or twelve sittings at intervals of three days, and each application should last for eight or ten minutes. The writer has seen, in some cases, the hearing permanently benefited. The benefit is sometimes unfortunately but temporary, and in most cases the results are nil. When subjective sounds exist as a prominent symptom, the continuous current very rarely relieves, and in a few cases aggravates this symptom. When it is considered that we are still unable to differentiate precisely the pathological conditions present in the labyrinth or auditory nerve, it is easy to see that great diversity must be shown in the effects of such a remedy as galvanism.

For *paralysis of the auditory nerve* vesicants over the mastoid region, iodide of potassium (f. 100), and strychnine used hypodermically (f. 90) or by the stomach (f. 97), are recommended; and, no doubt, each of them is occasionally useful. Politzer recommends the insertion into the canal of the ear of a plug of cotton soaked in a mixture composed of equal parts of sulphuric ether and glycerine. The same authority inflates the middle ear with air containing the vapour of sulphuric ether or ammonia by means of the catheter.

CHAPTER III.

TINNITUS AURIUM.

BY this term are meant sounds, which are perceived in the ear, but which have no objective cause outside the body. It is a common symptom in all forms of ear disease, and is sometimes a much greater distress to the patient than the defective hearing, with which it is generally associated. The most serious and distressing forms of tinnitus aurium are met with in affections of the labyrinth and auditory nerve, and are, in most cases, due to irritation of the nerve. This is not unfrequently the only symptom complained of by the patient, and the only one for which he comes for relief.

These sounds are usually divided into two classes—First, those which are due to some irritation of the auditory nerve, either at its terminal expansion in the labyrinth, in its course, or at its root in the brain, but where no vibrating body really exists; and, second, those due to the actual presence of sonorous vibrations originating either in the interior of the ear or in the structures in its vicinity. The sounds comprised in this class are sometimes called *entotic* subjective sounds, and properly speaking are objective sounds, but they are usually included under the term subjective sounds.

The *character of these sounds* as described by patients is extremely varied. It is evident in many cases that patients have a difficulty in describing them or in comparing them with any actual sound outside the body. In the efforts to describe them they often employ terms or comparisons suggested by their particular surroundings or occupations. Those of an intense character are often compared to steam blowing out of a pipe, the rushing sound of a great waterfall, or the sound of water over-flowing from a pot into the fire, or the constant shrieking of a locomotive. They are frequently described as buzzing, hissing, ringing, singing of a kettle, humming, or crackling. They are compared by many to the sound of a shell held to the ear, to the ringing of bells, to the ticking of a watch, to the bursting of bubbles, to the splashing of water, to the twittering of birds, to the rustling of wind among the leaves of trees. Some again are said to be of a beating or pulsating character, and are often compared to a constant hammering or the working of a pump. In some cases several different sounds may exist at the same time in the one ear, such as a pulsating and a buzzing one. During treatment it is sometimes found that one sound may pass away or very much diminish, while the other may remained unchanged.

They are described most frequently as being exactly in the ear, at other times as being in the side or back of the head, or "all over the head." While in some persons the character of the sound is such as to produce very little annoyance, in others it seems to be so intense and constant as to render life a burden, forbidding engagement in work or social enjoyment, and indeed cases are on record of patients seeking relief in self-destruction.

Occasionally, though rarely, these sounds are said to be of a *pleasant* nature, such as the singing of birds or a beautiful melody. The writer has a patient, a lady, who frequently hears in the interior of the head complete and correct tunes of sacred music, particularly the tune "Old Hundred," to which the metrical version of the 100th Psalm is commonly sung. She states, however, that the frequent repetition of these tunes has become monotonous, and would be gladly dispensed with.

Another point of distinction is their *constant* or *intermittent* character. Usually during stillness and solitude the noises appear to be much worse and more disturbing. Patients often declare that during the noise and bustle of daily work they scarcely perceive the sounds, but on returning home to the quietness of their rooms the sounds become very unpleasant. In other cases they are only experienced after indulgence in stimulants, over-exertion, mental emotion, or during colds in the head, dull, damp weather, &c. In many persons they are unceasing, except during sleep. They are usually aggravated by causes, which injuriously affect the hearing.

The relation of these sounds in the ear to the degree of impairment of hearing varies. We sometimes find very distressing noises with but slight impairment of hearing. Occasionally cases are met with where the hearing is normal. In such somewhat rare cases the tinnitus aurium is probably due to reflex influences, such as from the teeth or the naso-pharyngeal mucous membrane. It is often found in such cases that defective hearing comes on in the course of a shorter or longer time. More frequently, when the sounds are intense and continuous, the deafness is very considerable. Generally, if the acuteness of hearing improves, the noises diminish, while, on the other hand, with gradually advancing deafness the intensity of the sounds generally increases, until the patient may be deaf to all external sounds, while tormented by noises in his head. Sometimes, however, when the state of total deafness has been reached, the sounds completely cease, probably owing to complete loss of the functional activity of the auditory nerve.

Nearly all the diseases of the ear—outer, middle, or inner—may be accompanied by subjective noises. Those which depend upon some form of pressure or irritation applied to the auditory nerve may be caused (*a*) by morbid growths or products, especially in the roots or trunk of the nerve; (*b*) by abnormal pressure or tension of the labyrinthine fluid; or (*c*) by reflex irritation.

Abnormal pressure is probably the most common cause, and is exerted upon the fluid of the labyrinth chiefly through the fenestræ by pathological changes in the tympanic cavity. These, as we have already seen, are due to collections of exudation, swelling or thickening of the mucous membrane, or excessive pressure of the base of the stapes upon the fenestra ovalis. Of the diseases of the conducting apparatus of hearing, chronic dry catarrh is the most frequent and intractable cause. Here we have not only long-continued abnormal pressure upon the fluid of the labyrinth, leading often to nutritive changes in that part, but, owing to a rigid state of the membrane of the fenestra rotunda, which is often present, the pressure upon the fenestra ovalis has a more injurious effect upon the nervous structures of the labyrinth. In children tinnitus aurium is much less frequent and less severe than in adults, although, in the former, excess of pressure upon the fenestra ovalis is very common. The less severity is probably due to the yielding state of the membrane of the fenestra rotunda, and perhaps also to the wide aqueductus cochleæ, which exists in the child, the bulging of the former towards the tympanic cavity, and the partial escape of the fluid of the labyrinth through the aqueduct, relieving the delicate nerve structures from the excessive pressure. It is also to be remembered that, in addition to pathological changes in the middle ear, excessive pressure of cerumen or of inflammatory products upon the tympanic membrane may push the ossicular chain towards the fenestra ovalis. The terminal structures of the auditory nerve may also be exposed to pressure, not only from causes existing outside of the labyrinth, but also from dilated vessels, exudations, effusions, and thickenings within the labyrinth. Subjective sounds are much less frequent and severe in chronic suppurative diseases of the middle ear than in the chronic dry or adhesive catarrh.

The subjective sounds may be due to *reflex causes* acting either upon the auditory nerve or upon the vessels of the labyrinth. This reflex effect is frequently produced through the medium of the trigeminus or the facial nerves. Pressure or friction either upon the mastoid process, the cheek, the tragus, or the back of the neck may for a moment diminish or remove, or, on the contrary, may actually produce, a sound in the ear. Any irritation in the nasal or pharyngeal mucous membrane, in the gums or teeth, in the cutaneous lining of the external auditory canal, or in the mucous lining of the middle ear, may excite some form of tinnitus aurium in a reflex way by causing dilatation of the vessels of the labyrinth, or by exciting the nerve itself. It is very probable that irritation acting upon more distant parts may affect the labyrinth or nerve. Cold, for example, acting on the soles of the feet, when a person stands with bare feet on the cold ground, may excite a sounding in the ear. It is probable that there are reflex connections between the digestive organs, as the stomach, liver, &c., and the circulation in the labyrinth. We frequently see the auricle reddened from dilated vessels due to sympathetic connection, through the vaso-motor system, with other parts of the body; and the vessels of the deeper parts of the ear may have a similar sympathetic connection with other parts of the body.

The *entotic subjective sounds*, or those actually due to sonorous vibrations originating either within the ear or in its neighbourhood, may come from *blood-vessels*, from the *movements of secretion* in the ear, or from *muscular contraction* in the tympanum or Eustachian tube.

The jugular vein under the floor of the tympanum is often the source of the sound. At that point, where the lateral sinus passes into the bulb of the jugular vein, the calibre of the venous tube becomes abruptly narrowed, and a murmur in the ear is apt to be produced at this contracted part of the lumen. We find this sound most frequently in anæmic conditions, or when the walls of the vein have become thickened from some morbid process. A pulsating sound is sometimes heard in the ear owing to an abnormal state of the internal carotid artery, as it lies in the osseous canal in the temporal bone. This is usually caused by some obstruction to the current of blood, due to thickening of the inner coat of the artery or to thickening of the osseous canal. Again, the dilated condition of the arterioles in congestion of the labyrinth or of the external or middle ear gives rise to a very disagreeable sense of pulsation, which is described as a beating, hammering, or pumping in the ear. The sounds originating in the internal carotid artery or internal jugular vein are either stopped, or they are changed in character by pressure upon these trunks in the neck. Pressure upon the posterior auricular artery behind the ear sometimes also checks or allays these pulsating sounds in the ear. Most of these sounds connected with the blood-vessels are intensified, when any impediment, such as swelling or thickening of the tympanic mucous membrane, exists to the passage of sound outwards.

The presence of fluid secretion in the middle ear often calls forth sounds in the ear, especially during movements of the head. These are described by patients as crackling, slight splashing, or the bursting of bubbles. Creaking or rubbing movements may be heard, when excess of cerumen or a foreign body is in the outer canal of the ear.

The contraction of the muscles of the middle ear is frequently attended by noises. Tonic or clonic spasm of the tensor tympani or stapedius may give rise to a slight drumming or buzzing sensation in the ear. During the contraction of the abductor tubæ in swallowing, even in a normal state of the ear, most persons are conscious of a sound. When, however, the walls of the Eustachian tube are abnormally closely connected by means of catarrhal products, a crack or such like sound often signalizes the sudden separation of the membranous wall by the action of the abductor tubæ in swallowing.

Many of these subjective sounds are associated with what is indefinitely called a "nervous state." In such cases the intensity of the symptom is more than usually modified by varying states of the nervous system, aggravated by worry or irritation, and diminished by moods of contentment and serenity. A nervous condition is, on the other hand, apparently sometimes excited by some of the distressing forms of this symptom.

Schwartze and Köppe have directed attention to the association of subjective sounds in the ear with *hallucinations of hearing* in the insane. Even persons, who have no mental defect, sometimes, for a time, confound noises in the ear, such as whistling or the ringing of bells, with actual sounds originating outside. But in this case a little careful observation on the part of the patient is sufficient to convince him that the sound has no existence outside his body. Von Tröltsch relates a case of melancholia with hallucinations of sound in the ear like the crying of a child. The removal of impacted cerumen was immediately attended by the disappearance of the sound as well as of the melancholia. Other cases are on record of morbid states of the mind being connected with the existence of peripheral disease of the ear causing subjective sounds. Schwartze says, "Subjective sounds in the ears, which are occasioned by undoubted disease of the ear, may, in persons disposed to psychical disease, especially where hereditary tendency to such exists, be the direct cause of hallucinations of hearing, which may provoke at any time the outbreak of pronounced mental disease." The continuous hissing, buzzing, &c., which attend the ear disease, may be associated with the hearing of "voices." Two cases are related by Köppe, in each of which only one ear was diseased, and only on that side were the "voices" heard. In these two cases, as well as in several others, the noises and hallucinations disappeared under local treatment of the ear affection.

Treatment.—There is no actual specific remedy agains tinnitus aurium. The treatment is usually that of the particular affection of the ear, with which this symptom is associated, and our success will pretty much depend upon the nature of that affection. When connected with affections of the external auditory canal, with acute inflammation, suppurative inflammation, or mucous catarrh of the middle ear, the effects of treatment are usually very satisfactory. When, on the other hand, they are connected with adhesive catarrh of the middle ear, or disease of the labyrinth and auditory nerve, the prospect of completely removing the noises in the ear is very small. The most we can hope for, in the majority of such cases, is a certain measure of relief. This symptom is found in practice most frequently conjoined with chronic dry or adhesive catarrh, and the treatment already described for that condition is the most generally applicable for subjective sounds in the ear. Such treatment will frequently mitigate the symptoms temporarily or permanently, and this mitigation is usually accompanied by improvement of hearing, although it is sometimes otherwise. When the subjective sounds are attendant upon disease of the inner ear, and this is the case with the most severe forms, the treatment described for these affections must be resorted to.

We shall here refer to the use of external applications and certain special internal medicines, as well as to one or two points in general treatment.

Counter-Irritation behind the ear and in the external auditory canal has, in some cases, a mitigating influence on the noises. This may consist of vesication, or the application of the tincture or the ointment of iodine, or of a spirituous embrocation (see f. 11) employed over the mastoid process. Politzer speaks favourably of repeatedly painting the cartilaginous part of the external auditory canal, especially when there is abnormal dryness of the meatus, with liniment No. 15.

The subcutaneous injection of morphia into the back of the neck is sometimes resorted to, with temporarily good effect, in very violent and paroxysmal noises. The inflation of the vapour of chloroform or of sulphuric ether through the catheter (see p. 115) has sometimes a mitigating influence upon severe tinnitus.

While some patients state that they find partial relief to the sounds in the ear from pouring warm water or warm diluted glycerine into the ear, the pouring of fluids into the interior of the ear is generally useless and may be injurious.

The question has been raised by some writers of ligaturing the carotid or posterior auricular artery in those cases of extremely distressing sounds, which are removed by pressure on either of these vessels.

Certain special remedies have been suggested, and are employed, for the relief of subjective sounds in the ears. *Hydrobromic acid* (f. 119), suggested at first by its effect in counteracting the aural symptoms produced by quinine, has been much advocated by Dr. Woakes on the theory that it leads to contraction of the labyrinthine vessels. In only a few cases does this drug seem to have a beneficial effect, and the precise indications for its employment are not yet clearly ascertained.

Large doses of *bromide of potassium*, fifteen to thirty grains (Politzer), or one to two drachms (Urbantschitsch), are often of service in cases associated with an excitable state of the nervous system. From thirty to sixty grains dissolved in a large quantity of water every evening have often, for a time at least, a distinctly alleviating influence upon severe tinnitus.

Chloride of ammonium in twenty grain doses, three times a day, was proposed and strongly recommended by Hinton. When useful, which, in the experience of the writer, is but seldom, its effects are probably due to its action on the naso-pharyngeal mucous membrane.

Digitalis should be tried in the severely pulsating form, due to some morbid condition of the blood-vessels, as it has in some cases a mitigating effect.

Tincture of arnica (f. 115), *valerianate of zinc* (f. 116), and *Fowler's solution of arsenic* (f. 95), have each its advocates. They may be tried, when other measures are without effect. It has to be observed, in considering the merits of these medicaments, that some patients declare that a glass of cold water, or the eating of a morsel of food, has a temporarily good effect on the tinnitus, and that we are liable to mistake *post hoc* for *propter hoc.*

In the treatment of the persistent forms of subjective sounds in the ear, the state of the whole body should come under review, and appropriate medicinal, hygienic, or dietetic treatment should be employed to rectify, if possible, any departure from the healthy condition. The use of cathartics or mercurial preparations is in some cases very efficacious in giving relief, for a time at least, to the patient's distress. Some patients say that after a dose of Gregory's mixture, or a blue pill, followed by a saline, they enjoy a day or two's respite from the noises. If the hepatic functions are disturbed, and a torpid state of the bowels exists, a course of aperient waters, with an occasional mercurial, may temporarily relieve, if not altogether remove, the tinnitus (see f. 108 to 110).

CHAPTER IV.

DEAF-MUTISM.

DUMBNESS must not be looked upon as a separate or isolated disease. It is, in the vast majority of cases, simply a consequence of total or of a high degree of deafness, which has either been congenital, or has originated in the early years of life. Deafness for speech coming on under four years of age is certain to be attended by dumbness; and even between four and eight years of age, if great care is not exercised, and especially if the child has not learnt to read, or is of less than average intelligence, serious deafness is liable to be followed by loss of speech.

The deafness, which leads to mutism, may be *congenital* in its origin, or it may be *acquired* after birth.

Recent investigation seems to prove that the *congenital* form is somewhat less frequent than the acquired. The pathological conditions found in the congenital form are either defective formation of the ear, such as closure of the external auditory canals, absence of the fenestral openings, or partial or complete absence of the semicircular canals, or they are the results of intra-uterine inflammation of the labyrinth or middle ear. Sometimes, however, no pathological change can be discovered in any part of the ear. Hereditary influences probably play an important part in the production of these defects or diseases. It is somewhat remarkable, however, that only a very small proportion of the children of deaf-mutes have the affliction of their parents. On the other hand, several members of a family may be deaf-mutes, and yet no defect of hearing whatever exist in either of the parents. Indirect transmission of hereditary tendency to deaf-mutism seems to be much more frequent than direct. It is more common to find that the uncle or grand-uncle has been a deaf-mute, than the father or grandfather. The inter-marriage of relatives is said to be productive of a large number of deaf-mutes. According to Hartmann 8·1 per cent. of deaf-mutes are the offspring of consanguineous marriages. Some authorities, on the other hand, deny this. Probably these marriages are liable to produce defects in the descendants, only when serious constitutional anomalies exist in the family, from which both parents spring, in which they would both share. The probability is that, when the lineage of the two is healthy, the offspring does not suffer from the relationship of the parents.

In the *acquired* form of deaf-mutism, that is, where the deafness causing the mutism has originated after birth, the pathological conditions are very various. They are frequently in the labyrinth or nerve of hearing, and are the sequelæ of cerebral diseases, of cerebro-spinal or ordinary meningitis, of inflammation of the labyrinth, of injuries, of mumps, of scarlet fever, typhus fever, measles, diphtheria, &c. Pathological changes are not unfrequent also in the middle ear, as the consequences of catarrhal or inflammatory diseases. The most common are thickening or rigidity of the fenestral membranes, extensive adhesions, anchylosis of the stapes, and other effects of adhesive catarrh. At other times we find, owing to purulent inflammation, destruction of the tympanic membrane and ossicular chain. In all these cases, both ears must be seriously affected before leading to such a degree of deafness as to hinder the hearing of loud speaking. Hereditary influence probably plays a more important part in the causation of the acquired form of deaf-mutism than in the congenital.

It is useful to recognise two forms of acquired deaf-mutism. First, when the deafness arises so early in life (in the first year or two years), that the child has never spoken. It is evident that, if he does not hear words, he cannot learn to speak. Second, where the deafness affects the child after the power of speech has been partially or completely acquired, depriving him of speech. This may happen up till the seventh or eighth year of life.

The effects of deafness are very different in the child from the adult. A degree of deafness, which would rob the child of speech, or which would prevent him acquiring it, would probably in the adult interfere very little with his social intercourse. The adult, who becomes very deaf, retains his power of speech, because (1) it is so firmly implanted in his memory that he can never forget it; (2) his knowledge of language, and of the lip and facial movements made in speaking, enables him to guess, from the words which he does hear, the sense of those he fails to hear, and also to partially understand what is said from the visible movements of the lips; (3) he insists on hearing and understanding by asking the speakers to articulate loudly and distinctly; and, (4) his ability to read maintains and even extends his knowledge of language.

It is very different with the young child, who has only recently acquired, and that very partially, a knowledge of spoken language. For years this knowledge remains very limited and defective. His knowledge of the various and multiform sounds, with their meanings, which constitute spoken language, is attained very gradually and slowly, by frequent repetition of words in the hearing of the child in conjunction with the exhibition of the objects, qualities, or actions, which they represent. With a healthy mental condition and a normal state of the vocal organs (the latter are very rarely abnormal), the naturally strong imitative faculty of a child enables him to repeat the sounds, at first imperfectly; but gradually, as he repeatedly and accurately hears the same sounds, his intonation and pronunciation become more and more perfect. But, when the hearing of words becomes distinctly impaired, although far from being totally lost, a less perfect articulation is very early observed, as he fails to hear all the shades of sound, which make up articulate speech. If the child be of some age, and the deafness not yet very extreme, the effect upon speech may not be more serious than simply to render the pronunciation indistinct and ill-defined. If, however, the deafness becomes more aggravated, or if the child is very young, and has only recently attained a slight knowledge of speech, the pronunciation becomes more and more imperfect, and, his knowledge and memory of words being insufficient to keep what he has, he soon ceases altogether to speak, or his utterance is confined to unintelligible sounds. The child, unlike the adult, ceases to make any effort to hear, and finds it more easy to trust to signs, in the use of which he is usually encouraged by the parents. After a time, the parents, regarding the child as quite deaf, believe that it is quite useless to speak to him at all, resorting more and more to gestures, till the child comes to be classed as a confirmed deaf-mute. Did the parents take pains to speak in a loud and distinct voice near to the ears of the child, as they would to a deaf adult, and, by that means, maintain and even increase the child's knowledge of words, the consequences would be much less serious.

The proportion of deaf-mutes to the population, so far as statistical investigation informs us, is 7·77 to every 10,000. In Great Britain the proportion is 5·70 to the 10,000. In mountainous districts, the proportion is very much greater than in the plains. In Europe the largest number is in Switzerland, where there are 24·5 deaf-mutes for every 10,000 of the population. The Netherlands show the smallest proportion, 3·35 in the 10,000. It is conjectured that the excess in the mountain districts is due to the greater tendency in these regions to consanguineous marriages.

If a dumb child is brought before us for the first time, after the age at which speech should begin to be acquired, it is difficult to ascertain with certainty whether the child ever had the power of hearing. Parents are very unwilling to think that their child has never heard. Besides, it is not easy to determine positively, in the first year of life, especially in the first few months, whether a child hears. The mother may find that the child sleeps more soundly, and is found to be unaffected by noises, which disturb and waken other infants. But at this age, if we find the organs to be normal, so far as they come under objective examination, we cannot arrive at certainty. After the first year, it is generally possible to determine whether or not marked deafness exists. The mother's anxiety is aroused by the delay of the child in beginning to speak, and by its inattention to loud sounds produced in its neighbourhood. Suspicion being excited, the child should be tested in various ways. While its eyes are turned away from the source of sound, a bell or whistle is sounded, or the hands are clapped, or vowel sounds are loudly pronounced. If the attention of the child is not excited by these sounds, as shown by the head not being turned round towards the source of the sound, it may be concluded that there exists no actual power of perceiving sound. It is well that such tests should also be applied by the parents at home. In testing the child's power of perceiving the tuning-fork through the bones of the head or near the ear, we should first apply the tuning-fork to the forehead or near the ear, while it is silent, when the child's features will probably remain impassive; but, if applied afterwards while vibrating, the child's smile or cry of surprise will inform us that he hears the sounding fork. In this way we may generally ascertain the power of hearing a tuning-fork possessed by a child over two years of age.

It has been found by numerous examinations that about forty per cent. of deaf-mutes possess some modicum of hearing. Loud, sharp sounds are most frequently heard, or the loud pronunciation close to the ear of vowel sounds. In a smaller number complete words are heard, when shouted loudly into the ear. The use of the hearing tube may be, in these cases, an aid to instruction in articulate speech.

When deaf-mutes are allowed to grow up without training or education, they become extremely violent and possessed of little self-restraint. Their tempers are often ungovernable, and their passions uncontrolled.

In Politzer's experience deaf-mutism from congenital causes is more hopeful than total deafness if acquired. He has seen a number of cases of total deafness, of a congenital nature, during the first few years of life, in which ultimately partial, and in one case complete, hearing existed. He has not seen a single case of improvement in cases of deaf-mutism due to scarlatina, diphtheria, meningitis, or hydrocephalus.

Treatment.—We shall consider this under two heads—1st, the medical treatment, and, 2nd, the educational treatment.

1st, *The medical treatment* is mainly suited for the *acquired* form of deaf-mutism, and may in these cases be of the greatest value. The ear, in its various parts, should be carefully examined, and, if any disease exists, appropriate treatment should be employed. When, for example, mucous catarrh or chronic suppurative disease of the middle ear is the cause or one of the causes of the deafness, there is great hope of improving or even restoring the hearing power with subsequent recovery of speech. Every aural surgeon meets with cases now and again of delay in learning to speak, or of loss of speech in the young child, due to such remediable causes, where the child was rescued from what appeared to be pronounced deaf-mutism. In the congenital forms, and also in the acquired, when due to an obscure condition of the inner ear, galvanism by the continuous current should be tried. If greater attention were given to the treatment of diseases of the ear in childhood, mutism might in some cases be averted or cured. It would be desirable that the inmates of institutions for deaf-mutes should be examined by a surgeon, in order that, if any curable affection of the ear existed, proper treatment might be employed. It is to be remembered that even slight improvement of hearing may very much assist the educational treatment.

2nd, *The educational treatment* of deaf-mutes is a most interesting subject, which has of late years received great attention.

We shall first look at the efforts, which should be carried out to prevent dumbness in children, whose hearing is not completely lost. When a young child, who has commenced to speak, becomes deaf to the extent of not hearing words spoken in an ordinary tone of voice, he drifts gradually into mutism. In order to avert this, most diligent and painstaking efforts should be made to maintain his knowledge of spoken words, and even to add to his stock of them. A considerable amount of time should be devoted daily to speaking slowly, clearly, and in a sufficiently loud tone close to the ear of the child, who must also be made to repeat the words frequently. When the deafness is very marked, the aid of a hearing tube may be of service. In the severe forms instruction in lip-reading should also be carried out, and, by utilizing what hearing there is, the modulation and pronunciation may be corrected and improved. By efforts of this kind we may in some cases prevent the child lapsing into dumbness, and at the same time prevent that injury to the mental faculties, which is likely to result from his being partially or wholly shut out from spoken language at the most valuable educational period of life. We would here point out the importance of giving special attention to school children, who may suffer from defective hearing. Dr. Sexton, of America, has found, as the result of the examination of a large number of school children, that 13 per cent. suffered from greatly diminished hearing. Probably many children are regarded as stupid or inattentive, when defective hearing is the real cause of their seeming stupidity or inattention. When the hearing of a child attending school is found to be imperfect, he should occupy a place near to the teacher, and should otherwise receive special attention. It would be a great advantage, if there were institutions or schools, distinct from ordinary deaf and dumb institutions, where *partially* deaf children might be trained and educated, with special regard to their defect and wants.

There are two systems now in use for the education of deaf-mutes—1. *The French system*, by the manual alphabet and signs—*Dactylology;* 2. *The German system*, by lip-reading and articulate speech.

The *first* is the system, which has hitherto been practised in the institutions for the deaf and dumb, and it has been a great blessing to deaf-mutes. It is possible that the system of lip-reading may ultimately supersede this old method of communicating by visible signs; but the question of expense, time, &c., will be a barrier, for some time to come, to the exclusive use of the German method in our deaf and dumb institutions.

The German system * possesses most important advantages, and is the proper method of educating the deaf-mute, when it can be carried out, and when the children are thoroughly intelligent. They are enabled to understand, and be understood by, those around them. In the interchange of ideas they are not confined to deaf-mutes like themselves or to the limited number of speaking persons, who can communicate by manual signs. They, in short, cease to be dumb, and can, in great measure, take the place of a hearing person in society. The ability to speak tends to strengthen the pulmonary and vocal organs. By the frequent exercise of the organs of speech the development of the vocal structures and chest is stimulated, and possibly, in some cases, pulmonary disease, if there is a constitutional tendency to it, may be averted. The perfection of speech and lip-reading attained by this method varies no doubt according to the intelligence and aptitude of the child, the qualifications of the teacher, the age at which it is commenced, the length of time during which it is carried on, and whether or not the child possesses any modicum of hearing. There is no doubt there are some deaf-mute children, who, although free from any mental defect, lack the intelligence and quickness necessary to make them clear and distinct speakers or very proficient in lip-reading. The qualities of the teacher have also a great influence on the results. He should be actuated by enthusiasm in his calling and possessed of a painstaking perseverance of no ordinary kind, besides having received a thorough training in all the details of the system. It is of great importance that the child should begin early, in the seventh year if possible, and that the teaching should extend over ten or twelve years. Parents are very ready to remove their children from the institution, when they reach an age for profitable employment, and before they have attained sufficient proficiency in lip-reading and speaking. To make this method efficient in institutions for deaf-mutes, powers should be granted to the directors to prevent the removal of children before the teacher is satisfied of their proficiency. If the child possess a small amount of hearing, so as to distinguish words or vowels loudly spoken into the ear, the modulation and pronunciation can be made much more natural than in the totally deaf child, whose pronunciation has usually a disagreeable harshness. Probably, in some cases, the use of the hearing tube would assist in utilizing any modicum of hearing power remaining, not only by enabling the child to hear the teacher's voice, but also correcting his own articulation, when speaking or reading into the tube himself.

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* Any one interested in this subject may have the opportunity of observing practically the teaching of lip-reading and articulate speech either at Miss Griffith's school, Glasgow, or at the Deaf and Dumb Institution, Crosshill, by communicating with Mr. Thomson there.

Some authorities recommend the use of *dactylology* in conjunction with this method, during the first year or two, as facilitating the acquirement of the meanings of words, while others put great stress upon the importance of entirely excluding manual signs as a condition of success with the German method.

Instruction in lip-reading is probably not sufficiently taken advantage of by adult persons, who have become totally deaf after the age of childhood, and who, though able to talk themselves, can make out very little of what is spoken by others. In the case of such it might prove of considerable advantage, if they received methodical instruction from qualified teachers in lip-reading.

In order that deaf-mutes belonging to the humbler classes of the population may derive the advantage of being instructed on this system, it would be necessary that a government grant be extended to deaf and dumb institutions in this country to meet the great additional expense involved in carrying it out. Surely children, who are placed under such a terrible disadvantage as total deafness, are as much entitled to government aid as children who hear.

APPENDIX.

I.

Otalgia.

PAIN is not unfrequently complained of in the ear, when objective examination shows no inflammatory process to be present. The pain is usually sharp and darting, disappearing and recurring, sometimes at regular but more commonly at irregular intervals. In this intermittent way otalgia may prove troublesome for days, months, or even years. It is frequently simply a part of a general neuralgic affection of the fifth nerve. It is frequently also reflex in its character, as in caries of the teeth, ulceration of the pharynx or larynx. Pressure upon the nerves, either inside or outside the ear, also excites otalgia. In the ear the pressure may be exerted by catarrhal thickening of the mucous membrane, which may excite pains in the side of the head. The pain is in some cases, though not commonly, localized in the auricle. In a case, which came under the observation of the writer, an intense neuralgia of the upper part of the anterior surface of the auricle, lasting for many months, was found to be associated with albuminuria. It most frequently, however, affects the tympanic plexus (glossopharyngeal and trigeminus) in the mucous lining of the tympanum. It is to be remembered that inflammation in the middle ear is not unfrequently regarded by medical men as neuralgia, if no objective examination is employed. As in the case of neuralgia elsewhere, it may here be caused by anæmia, syphilis, or the action of cold.

Treatment.—Vesicants behind the auricle are often useful. The application to the neighbourhood of the ear of sedative liniments (f. 13) is generally attended by relief, or a few drops of the sedative liniment, on a plug of cotton inserted into the external meatus, may prove more useful. The subcutaneous injection of morphia may be required in intense and persistent forms. The teeth should be examined, and, if caries with pain on pressure is discovered in a tooth, it should be extracted or stopped. Galvanism may be effective in removing neuralgia, which has resisted every other method of treatment.

Large doses of quinine (f. 122) should be tried; its combination with iodide of potassium, especially if syphilis is suspected, may be of great advantage. If the patient is anæmic, iron (f. 91 to 94) or arsenic (f. 95) should be prescribed, along with nutritious food and fresh country air.

II.

Nervous and Vascular Supply of the Ear.

It may help to simplify the study of the nervous and vascular supply of the ear, if, instead of describing them under each of the divisions of the ear, we present a connected view of the subject.

a. Nervous Supply of the Ear.

The *sensory* nerves supplying the various parts of the ear are derived from, 1. The great auricular from the cervical plexus; 2. The facial; 3. The pneumogastric; 4. The third division of the fifth cranial nerve; 5. The glossopharyngeal; 6. The large and small superficial petrosal nerves.

1. *The great auricular nerve* supplies the posterior part

of the auricle, the outer surface of the lobule, and a small part above the lobule, as well as the integument over the mastoid process.

2. The *facial nerve* sends twigs to the posterior aspect of the auricle. It communicates with the auricular branch of the pneumogastric.

3. A twig is given off from the jugular ganglion of the *pneumogastric*, pierces the bone, is distributed chiefly to the skin of the posterior wall of the external canal of the ear, and joins the facial nerve behind the auricle. This share of the pneumogastric in the innervation of the canal of the ear accounts for certain reflex phenomena, such as coughing, &c., not unfrequently observed, when the canal of the ear is touched with a speculum or other instrument, or pressed upon by a foreign body.

4. The *third division of the fifth cranial nerve* gives off the auriculo-temporal, which distributes branches to the outer surface of the auricle, to the walls of the external auditory canal, and to the outer layer of the tympanic membrane. The ramifications of this nerve impart to the canal of the ear and to the dermoid layer of the tympanic membrane their acute sensitiveness.

5. The *glosso-pharyngeal nerve*, by means of Jacobson's nerve branching off in the jugular fossa, has the most important share in forming the tympanic plexus, which occupies the grooves on the inner wall of the tympanum, and supplies the lining of the middle ear with sensation. In making applications to the inner wall of the tympanum, patients not unfrequently feel as if the throat were touched, which is due to this twig from the glosso-pharyngeal nerve.

6. The *large and small superficial petrosal nerves*, from the spheno-palatine and the otic ganglion respectively, are connected with the tympanic plexus.

The *tympanic plexus* (Fig. 115) is made up of—1. Jacobson's nerve; 2. Twigs from the sympathetic plexus surrounding the carotid artery in its canal; 3. A communication with the great superficial petrosal nerve (a branch which connects the Vidian nerve, from *Meckel's ganglion*, with the facial nerve in the Fallopian canal); 4. The small superficial petrosal nerve, which connects the nerve of Jacobson with the otic ganglion and the facial nerve.

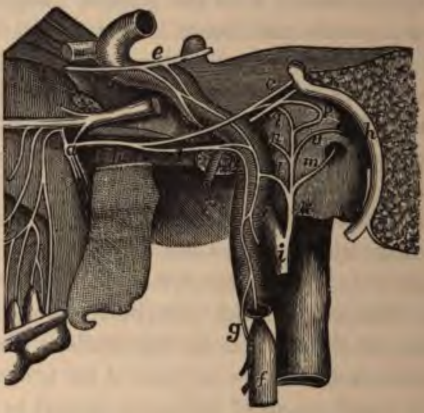

FIG. 115.—View of the tympanic plexus of nerves (after Hirschfeld and Leveillé)—*a*, spheno-palatine ganglion; *b*, Vidian nerve; *c*, great superficial petrosal nerve; *d*, carotid branch of the Vidian nerve; *e*, part of the sixth nerve, connected by twigs with the sympathetic; *f*, superior cervical ganglion of the sympathetic; *g*, carotid branch; *h*, facial nerve; *i*, glosso-pharyngeal nerve; *k*, nerve of Jacobson; *l*, its twig to the sympathetic; *m*, filament to the fenestra rotunda; *n*, filament to the Eustachian tube; *o*, filament to the fenestra ovalis; *p*, union of external deep petrosal nerve with the lesser superficial petrosal; *q*, internal deep petrosal twig uniting with the great superficial petrosal.

The *chorda tympani* nerve gives off no branch to the tympanum, merely passing through that cavity. If the view, held by some anatomists, that its fibres are really a continuation of the large superficial petrosal nerve, is correct, there is a connection between the chorda tympani and the plexus supplying the middle ear. The position of the chorda tympani on the inner surface of the tympanic membrane probably accounts for the anomalies of taste, sometimes found in patients suffering from chronic suppurative inflammation of the middle ear, and also for peculiar sensations in the tongue, sometimes excited when the nerve is touched with a probe.

The *motor* nerves supplying the muscles of the ear are derived from the following sources, and have the following distribution.

1. The muscles of the auricle are supplied chiefly by the posterior auricular and temporal branches of the facial nerve. 2. The tensor tympani and the abductor tubæ receive their nervous supply from the otic ganglion through the motor root of the internal pterygoid nerve from the third division of the fifth nerve. 3. The stapedius is supplied by the facial nerve. 4. The levator palati is supplied by the pneumogastric, and, according to some authorities, also by twigs from Meckel's ganglion.

The *otic ganglion*, situated at the outer part of the cartilaginous Eustachian tube, controls and regulates the reflex and sympathetic relations of the different parts of the organ of hearing to one another, and to near or distant regions of the body. This ganglion is formed of, 1. Motor and sensory fibres from the third division of the fifth cranial nerve, namely, the internal pterygoid and the auriculo-temporal nerves; 2. Fibres from the sympathetic round the middle meningeal artery; 3. Fibres from the glosso-pharyngeal and facial nerves through the small superficial petrosal.

The otic ganglion also gives off branches to supply the tensor tympani and abductor tubæ muscles. This ganglion is thus connected with the nerves, which supply the various parts of the external and middle ear. In this way also, from a distant centre of irritation, such as the teeth, vaso-motor changes are produced through the sympathetic, leading to dilatation of vessels and ultimate inflammation in the linings of the ear, or in the labyrinthine blood-vessels.

b. Vascular Supply of the Ear.

1. The arterial supply of the external and middle ear is derived almost altogether from the *external carotid artery*. Only one or two twigs are given off by the *internal carotid*, in the carotid canal, to a part of the Eustachian tube and tympanum. The following are the branches and terminal divisions of the external carotid supplied to the different sections of the ear.

a. The *posterior auricular artery* supplies chiefly the inner surface of the auricle, and partially the external auditory canal. It gives off the stylo-mastoid artery, which is distributed to the neurilemma of the facial nerve, to the mastoid cells, and to the posterior part of the tympanum and stapedius. A few twigs also penetrate the inner wall of the tympanum to the labyrinth, and anastomose with the internal auditory artery.

b. The *occipital artery* provides an auricular branch to the back of the concha.

c. The *temporal artery* gives off the anterior auricular to the fore-part of the auricle, to the lobule, and a small part of the external auditory canal.

d. The *internal maxillary artery* provides several branches to the ear—1. The deep auricular, supplying the tragus, the deep parts of the external auditory canal, and the outer layer of the tympanic membrane. The chief branches to the membrane pass down from the roof of the canal. 2. A tympanic branch is sent off, chiefly to the inner layer of the membrane. 3. From the middle meningeal the petrous branch penetrates to the tympanum and Eustachian tube, through the hiatus Fallopii and petro-squamosal fissure. 4.

The Vidian sends small branches to the Eustachian tube and tympanum.

e. The *ascending pharyngeal artery* supplies small twigs to the Eustachian tube and tympanum.

2. The inner ear receives its chief vascular supply from the *internal auditory artery*, a branch of the basilar. A few twigs are provided by the stylo-mastoid artery, by which also the circulation of the outer and middle ear is connected with that of the inner ear.

The venous blood from the external and middle ear is discharged partly into the external and partly into the internal jugular veins, by means of branches corresponding to the arteries.

The venous blood from the labyrinth is discharged by the superior petrosal sinus into the lateral sinus.

FORMULÆ.

A.—LOCAL REMEDIES.

I. Caustics.

1. Argenti Nitras.

A probe made of aluminium is made red hot at the point and pressed on to the salt so that a coating of the fused salt will remain attached; or, the nitrate of silver is melted in a porcelain crucible over a spirit lamp and run into a suitable mould.

Use—As an application to localized swelling or thickening of the nasal or pharyngeal mucous membrane; to adenoid vegetations in roof of pharynx; to granulations in external auditory canal or middle ear; to condylomata in external auditory canal; to roots of polypi.

2. ℞ Acid. Chromic.
Aquæ *aa.* ʒi. M.

Use—For destroying roots of polypi or hypertrophied mucous membrane.

3. ℞ Acid. Chloro-Acetici ʒi.

Use—Same as above.

4. Pasta Londinensis ("London Paste"); *i.e.*,
Caustic soda and
Unslaked lime, of each equal parts.

Reduce to a fine powder in a warm mortar, and mix intimately. Keep in well closed bottles, and when required make a small portion into a paste with a little water.

Use—For applying to the individual thickened parts in granular pharyngitis; also as an application to enlarged tonsils.

II. Embrocations and Counter-Irritants.

5. ℞ Liquor.Carb.Deterg. ℥i.
Aquæ *ad* ℥vi. M.

Use—In chronic scaly eczema of auricle. The parts affected should be sponged every six hours.

6. ℞ Tinct. Iodi ʒiv.

Use—Recommended by some writers as an application to hyperostotic swelling of external auditory canal. In the milder cases of mastoid periostitis and in disease of the labyrinth, especially when associated with tinnitus aurium, it is useful when applied behind auricle.

7. ℞ Liniment. Iodi ʒiv.

Use—As a counter-irritant over mastoid process, especially in facial paralysis, when it may also be applied in front of the ear.

8. ℞ Emp. Cantharidis Liquid. (Smith's) ʒi.

Use—For producing vesication when painted over mastoid process, especially in facial paralysis, in labyrinthine disease, in paralysis of auditory nerve, and in distressing forms of tinnitus aurium; also useful in otalgia.

9. ℞ Liquor. Plumbi Subacet. ʒi.
Glycerini Puri ʒij.
Aquæ *ad* ℥iv. M.

Use—In acute eczema or diffuse inflammation of auricle, the parts affected are to be gently but frequently sponged; or pieces of soft cloth dipped in the lotion are to be kept constantly in contact with the morbid surface.

10. ℞ Zinci Carb.
Pulv. Zinci Oxidi *aa.* ʒij.
Acid. Nitric. Dil. ♏x.
Sp. Vini Rect. ʒij.
Aquæ *ad* ℥iv. M.

Use—In eczema of auricle, parts affected are to be gently sponged two or three times a day.

11. ℞ Liniment. Saponis
,, Camphor. Co. *aa.* ℥i. M.

Use—In tinnitus aurium it is sometimes beneficial when applied with friction to the neighbourhood of the ear.

12. ℞ Liniment. Belladon.
,, Opii *aa.* ʒiv. M.

Use—A few drops placed on a pellet of cotton wool and laid in the outer orifice of the ear gives great relief in painful inflammatory affections of middle ear, or in simple otalgia.

13. ℞ Liniment. Chloroform.
,, Aconiti
,, Belladon.
,, Opii *aa.* ʒiv.
,, Saponis ℥i. M.

Use—Applied to the neighbourhood of the ear, this liniment allays the pain, which often extends along the temples and head, in inflammatory affections of middle ear, as well as in otalgia.

14. ℞ Æther. Sulphuric.
Glycerini Puri *aa.* ʒij. M.

Use—A plug of cotton soaked in this and inserted into meatus is said by Politzer to be useful in torpidity of the auditory nerve.

15. ℞ Tinct. Valerian. ʒij.
Æther. Sulphuric. ʒi.
Glycerini Puri ℥xij. M.

Use—For painting repeatedly the cartilaginous part of the external auditory canal in tinnitus aurium (Politzer).

III. Ointments.

16. ℞ Hydrarg. Oxid. Rub.
Hydrarg. Ammoniat. *aa.* gr. vi.
Adipis Benzoat. ℥i.
Ol. Olivæ Opt. ʒij. M.

Use—For dry, scaly eczema of the auricle; also for eczematous thickening of the external auditory canal, when the ointment is applied on cotton plugs.

17. ℞ Hydrarg. Oxid. Rub. gr. iv.
Ol. Rusci ♏vi.
Vaselin. ℥i. M.

Use — For chronic eczema, especially of the dry variety, of the auricle or external auditory canal.

18. ℞ Ung. Diachyl. ʒi. (not official).

Use—In the more acute forms of eczema, when the parts are to be frequently anointed or the ointment kept constantly applied on a piece of soft rag.

19. ℞ Ung. Zinci Oxid. ʒvi.
Liniment. Calcis ʒij. M.

Use—In eczematous conditions inside the nostrils; also in eczema of the auricle.

20. ℞ Liniment. Calcis
Ung. Hydr. Nitratis *aa.* ʒiss.
Liq. Carbonis Detergent. ♏ xij.
Ung. Zinci Oxid. *ad* ℥i. M.

Use—For chronic scaly eczema of the auricle or external auditory canal.

21. ℞ Iodoformi ʒi.
Ung. Simplicis *ad* ℥i. M.

Use—For applying to mastoid process in syphilis of labyrinth.

22. ℞ Ung. Hydrarg. ℥i.

Use—Same as last formula. Rubbed into the inside of the arms and thighs, it is employed for the constitutional anti-syphilitic effect.

23. ℞ Ung. Iodi ʒi.

Use—For applying to mastoid process in thickening of the tympanic membrane (Wilde); also in chronic suppurations of middle ear if the patient is syphilitic or scrofulous. In milder cases of mastoid periostitis, and in disease of the labyrinth, it is sometimes useful, when applied behind the auricle; also when there is tinnitus aurium.

24. ℞ Ung. Picis
,, Zinci Oxid. *aa.* ʒiv. M.

Use—In dry or scaly eczema of the auricle.

25. ℞ Acid. Boracic. (in pulv. subtil.) gr. x.
Vaselin. ℥i. M.

Use—For painting walls of external auditory canal in cases of furunculi.

26. ℞ Iodoformi gr. x.
Vaselin. ℥i. M.

Use—As an application to syphilitic condylomata or ulceration, or to simple abrasions or ulcerations inside nostrils.

27. ℞ Morphiæ Acetat. gr. i.
Vaselin. ʒi. M.

Use—For anointing walls of external canal, when there are boils or other painful inflammations.

IV. Powders.

28. ℞ Aluminis Exsiccat. ʒi.

Use—In thickening of the nasal or pharyngeal mucous membrane or adenoid vegetations in roof of pharynx (see p. 89); in chronic purulent inflammation of the middle ear (see p. 371); for destruction of fungi; and after removing polypi.

29. ℞ Iodoformi ʒiv.

(This may now be obtained with the persistent odour considerably masked.)

Use—In chronic suppuration of middle ear, especially as an application to a carious spot.

30. ℞ Acid. Boracic. (in pulv. subtil.) ʒi.

(For the mode of application see p. 365.)

Use—In purulent affections of the ear; especially useful in acute and chronic suppurative inflammation of the middle ear (see p. 364). Politzer recommends in some cases that carbolic acid in the proportion of 1 to 15 of boracic acid, or salicylic acid in the proportion of 1 to 2 should be added.

31. ℞ Pulv. Amyli ʒiii.
Zinci Oxidi ʒi.
Calaminæ ʒss. M.

Use—For dusting parts in acute eczema of auricle.

V. Solutions

For dropping into ear or applying to interior of ear by means of a probe or cotton on a cotton holder.

(For description of methods of application see pp. 200 and 333, and for astringents p. 370.)

32. ℞ Plumbi Acetatis gr. iv.
Aquæ ℥i. M.

Use—In acute purulent inflammation of middle ear; also in chronic purulent disease of the external auditory canal and middle ear.

33. ℞ Acid. Boracic. ʒss.
Sp. Vini Rect. ℥i. M.

Use—In chronic otitis externa, and in furunculi of the canal.

34. ℞ Liq. Plumbi Subacet. ʒiv.

Use—To be applied with camel-hair brush or cotton on a cotton holder to unhealthy granulations in external auditory canal.

35. ℞ Zinci Sulphatis gr. viij.
Acid. Carbolic. Cryst. gr. iv.
Glycerini Puri ʒi.
Aquæ *ad* ℥ij. M.

Use—Astringent and antiseptic. For chronic purulent affections of the external auditory canal and middle ear.

36. ℞ Cupri Sulphatis gr. iv.
Aquæ ℥i.

Use—Astringent drops in chronic purulent affections of the ear.

37. ℞ Hydrarg. Perchlorid. gr. iv.
Aquæ ℥i. M.

Use—A few drops instilled into ear in syphilitic disease of the external auditory canal, or in fungi of the ear.

38. ℞ Sp. Vini Rect. ℥i.

Use—For fungi in the ear and for destroying larvæ in external auditory canal. Excellent remedy in some cases of chronic purulent disease of the middle ear; especially suitable when granulations or small polypi have sprung up. (See p. 369, and for roots of polypi see p. 386.)

39. ℞ Acid. Carbolic. Cryst. ʒi.
Sp. Vini Rect.
Aquæ *aa.* ʒxv. M.

Use—Twelve or fifteen drops are instilled into the ear after thorough cleansing and drying in chronic purulent inflammation of middle ear. Politzer gradually increases the carbolic acid to twice this strength.

40. ℞ Iodoformi ʒss.
Sp. Vini Rect. ℥i. M.

Use—In chronic purulent inflammation of middle ear. (See p. 367.)

41. ℞ Acid. Salicylic. gr. ij.—x.
Spirit. Vini Rectif. ℥i. M.

Use—In chronic purulent inflammation of middle ear (Burckhardt-Merian). It may prove irritating in the larger proportions.

42. ℞ Sodæ Bicarb. gr. x.
Glycerini Puri ʒi.
Aquæ *ad* ℥i. M.

Use—For softening ceruminous collections prior to syringing; also dropped into the ear when purulent secretion is thick and perforation in membrane small. (See p. 334.)

43. ℞ Morphiæ Hydrochlor. gr. iv.
Aquæ ʒiv. Solve.

Use—For painful inflammations of external auditory canal, tympanic membrane, or middle ear. Ten drops to be warmed and instilled into the ear every two or three hours.

44. ℞ Argent. Nitrat. gr. xl.
Aquæ ℥i. Solve.

Use—In chronic naso-pharyngeal catarrh (for mode of application to nasal mucous membrane see p. 86); also as an application to the outer orifice of the ear in chronic scaly eczema; also for painting over the walls of the external canal when the cutaneous lining is thickened; in syphilitic ulcerations; also applied through the catheter to the pharyngeal mouth of the Eustachian tube (see p. 87). In acute suppurative inflammation of middle ear. In chronic suppuration of the middle ear (see p. 368).

45. ℞ Liq. Ferri Perchlorid. ʒij.

Use—For touching granulations or roots of polypi in external auditory canal or middle ear to ensure their destruction.

VI. Solutions

For applying chiefly to the middle ear through the Eustachian catheter in chronic catarrh of middle ear or in muco-serous catarrh, when the swelling of the mucous membrane persists.

(For mode of application see pp. 112 and 295.)

46. ℞ Ammonii Chlorid. gr. v.
Aquæ ℥i. Solve.

47. ℞ Sodæ Bicarb. gr. x.
Aquæ ℥i. Solve.

48. ℞ Zinci Sulph. gr. v.
Aquæ ℥i. Solve.

Use—Only suitable in swelling and hypersecretion of the mucous membrane.

49. ℞ Potassii Iodidi gr. v.
Aquæ ℥i. Solve.

Use—In addition to above, supposed by some writers to assist the absorption of syphilitic products in interior of the labyrinth.

VII. Solutions

For cleansing and disinfecting the ear or nasal passages.

(For description of mode of application see pp. 81 and 361.)

50. ℞ Glycerin. Acid. Carbolic. ℥iv.

Use—One or two teaspoonfuls to be added to four ounces of warm water as an injection in chronic naso-pharyngeal catarrh; specially suitable for ozæna; also in chronic suppurative diseases of external auditory canal or middle ear; also for fungi in the ear.

51. ℞ Liq. Potass. Permangan. ℥iv.

Use—Forty drops to be added to four ounces of warm water as an injection in chronic naso-pharyngeal catarrh; specially suitable for ozæna; also in chronic suppurative diseases of external auditory canal or middle ear; also for fungi in the ear.

52. ℞ Acid. Salicylic. ʒss.
Boracis ʒij.
Aquæ ℥xx. Solve.

Use—Injection in fœtid otorrhœa and ozæna; also for fungi in the ear.

53. ℞ Acid. Boracic. ʒvi.
Aquæ ℥xx. Solve.

Use—Disinfecting injection, suitable for all forms of suppurative diseases of the middle ear.

54. ℞ Sodii Chlorid.
Sodæ Bicarb. *aa.* ʒi.
Aquæ ℥xx. Solve.

Use — Alkaline and slightly stimulating. Employed with advantage in chronic naso-pharyngeal catarrh; also as an injection in suppurative diseases of the middle ear.

55. ℞ Potassæ Chloratis ʒss.
Glycerin. Boracis ʒij.
,, Acid. Carbolic. ʒi.
Aquæ *ad* ℥xx. M.

Use—Antiseptic and alkaline. Employed as a cleansing application in chronic naso-pharyngeal catarrh.

56. ℞ Liq. Sodæ Chloratæ ℥i.
Aquæ *ad* ℥xx. M.

Use—In chronic naso-pharyngeal catarrh; especially suitable for ozæna; also as a means of destroying larvæ in the ear (Roosa).

57. ℞ Sodæ Salicylatis
Sodæ Bicarb.
Potassæ Chloratis *aa.* ʒiv. M.

Sig.—As much as will cover the point of a pen-knife to an ounce of water, to which a drop of turpentine may be added.

Use—In chronic naso-pharyngeal catarrh, and in chronic suppurative disease of the middle ear.

58. ℞ Boracis ʒvi.
Aquæ ℥xx. Solve.

Use—Injection in otitis externa diffusa. Half this strength is used for injecting through the Eustachian tube.

VIII. Solutions

For application to the mucous membrane of the nasal passages or upper pharyngeal cavity.

(The methods of applying these solutions are described at p. 85.)

59. ℞ Acid. Tannic. ʒi.
Acid. Salicylic. gr. x.
Aquæ ℥xx. Solve.

Use—In chronic naso-pharyngeal catarrh.

60. ℞ Zinci Sulpho-Carbolatis gr. xl.
Aquæ ℥xx. Solve.

Use—Astringent and antiseptic. As above.

61. ℞ Alum. Exsicc. gr. lxxx.
Aquæ ℥xx. M.

Use—Astringent. As above.

62. ℞ Acid. Tannic. ʒiss.
Aquæ ℥xx. Solve.

Use—Simple astringent. As above.

63. ℞ Ferro-Aluminis gr. xxiv.
Aquæ ℥viij. Solve.

Use—Astringent. As above.

64. ℞ Ammonii Chlorid. ʒss.
Aquæ ℥vi. Solve.

Use—Stimulant. As above.

IX. Solutions

Suitable for painting the throat for localized or general thickening or congestive swelling of the mucous membrane of the posterior wall of the pharynx (see p. 91).

65. ℞ Ferri Perchlorid. ʒi.
Aquæ ℥i. Solve.

66. ℞ Glycerin. Acid. Tannic. ʒiv.

67. ℞ Cupri Sulphatis gr. xv.
Aquæ ℥i. Solve.

68. ℞ Tinct. Iodi ʒiv.

69. ℞ Argenti Nitratis gr. xxx.
Aquæ ℥i. Solve.

X. Gargles

Employed in "relaxed," swollen, or softened states of the mucous membrane of the throat.

(For proper mode of gargling see p. 90.)

70. ℞ Boracis ʒij.
Glycerini Puri ʒij.
Aquæ Rosæ *ad* ℥viij. M.

Use—Mild alkaline astringent.

71. ℞ Alum. Exsicc. ʒi.
Aquæ Rosæ ℥viij. Solve.
Use—Astringent.

72. ℞ Liq. Hydrarg. Perchlorid. ʒiij.
Aquæ *ad* ℥viij. M.
Use—In syphilitic pharyngitis.

73. ℞ Glycer. Acid. Tannic. ʒvi.
Sp. Vini Rect. ʒij.
Aquæ *ad* ℥viij. M.
Use—Astringent.

74. ℞ Potassæ Chloratis ʒiv.
Sig. Dissolve in a pint of water, and use as a gargle.

XI. Lozenges

Suitable for congested or relaxed states of the throat. From Pharmacopœia of "London Throat Hospital."

These should be dissolved slowly in the mouth, and no liquid swallowed for a short time afterwards.

75. ℞ Troch. Krameriæ ℥i.
Sig. One every four hours.
Use—A good astringent.

76. ℞ Troch. Acid. Benzoic. ℥i.
Use—As last.

77. ℞ Troch. Cubebæ ℥i.
Use — Especially beneficial when there is excessive secretion from pharynx.

78. ℞ Troch. Guaiaci ℥i.
Sig. One every two hours.
Use—In acute inflammation of tonsils.

XII. Nasal Inhalations.

1st. Steam Inhalations (at a temperature of 140° F.). In inhaling, an India-rubber nasal piece is placed over the mouth-piece of an ordinary inhaler. Dr. Whistler's nasal piece is very convenient.

79. ℞ Tinct. Benzoin. Co. ℥ij.
Sig.—A teaspoonful in a pint of water.
Use—Sedative, in acute and chronic naso-pharyngeal catarrh.

80. ℞ Acid. Acetici ℥ii.
Sig.—Two teaspoonfuls in a pint of water.
Use—Sedative and antiseptic, as above.

81. ℞ Sp. Camphoræ ʒij.
Sp. Vini Rect. ʒvi.
Aquæ *ad* ℥ij. M.
Sig.—A teaspoonful in a pint of water.
Use—In acute and chronic naso-pharyngeal catarrh.

82. ℞ Acid. Carbolic. ℥i.
Aquæ ʒiv. M.
Sig.—A teaspoonful in a pint of water.
Use.—Antiseptic, as above.

83. ℞ Creasoti ♏.lxxx.
Magnes. Carb. Levis ʒss.
Aquæ *ad* ℥i. M.

Sig.—A teaspoonful in a pint of water.

Use—As above, and particularly in ozæna.

2nd. Dry Inhalations.

84. ℞ Acid. Carbolic. ʒi.
Alcohol. Absol. ℥iij.
Liq. Ammon. Fort. ʒi.
Aquæ ʒij. M.

"Hagar's Anti-catarrhal Mixture." To be kept in a glass-stoppered dark bottle.

Sig.—A few drops are poured on several layers of blotting paper folded in a cone; this is held to the nose, while the patient—whose eyes should be closed—inspires deeply as long as vapour is given off. The process is repeated every two hours. Or it may be conveniently used with a perforated naso-oral inhaler.

Use—In acute nasal catarrh it helps to cut short that disease.

85. Ammonii Chloridum; in its nascent state (see page 115) conveniently produced and applied by means of Burrough's, Felton's, or Lawin's inhaler.

Use—In acute and chronic catarrh of nasal and pharyngeal mucous membrane.

86. Vapor Iodi. (See page 74.)
Use—In acute nasal catarrh.

3rd. Atomized or Spray Inhalations.

87. ℞ Liq. Morphiæ Hydrochlor. ʒij.
Aquæ ʒij. M.

Use—A teaspoonful introduced in the form of spray into the nasal passages sometimes cuts short coryza at the early stage.

Note—All the solutions used for cleansing and disinfecting (Nos. 50 to 58), and all those for application to the nasal mucous membrane (Nos. 59 to 64), may be employed in form of spray.

B.—GENERAL REMEDIES.

1. Subcutaneous.
2. Internal.

I. Subcutaneous Injections.

88. ℞ Inject. Morphiæ Hypodermic. P.B. ʒij.

Sig.—One to six minims to be subcutaneously injected.

Use—Sometimes called for in very painful inflammatory affections of the ear; sometimes resorted to, with temporarily good effect, in very violent and paroxysmal tinnitus aurium; may be required for the relief of intense otalgia.

89. ℞ Sol. Pilocarpin. Nitrat. (2 per cent.) ʒi.

Four to ten minims for each injection.

Use—In syphilitic disease of labyrinth, also in Ménière's disease.

90. ℞ Liq. Strychniæ P.B. ʒi.

Use—For torpidity of auditory nerve. Two minims for each injection.

II. Internal Remedies.

(a.) *Remedies employed chiefly when the ear affection is associated with anæmia.*

91. ℞ Liq. Ferri Dialysat. ℥ij.

Sig.—Fifteen to thirty drops thrice daily. To be used for a long time.

92. ℞ Ferri Carb. Sacch. ℥ij.

Sig.—Fifteen grains stirred up in a glass of water thrice daily.

93. ℞ Pil. Ferri (Blaud).

Sig.—Two pills three times daily.

94. ℞ Mist. Ferri Co. ℥x.

Sig.—A dessertspoonful thrice daily.

This is the old "Griffith's Mixture." A very useful and easily assimilated preparation of iron.

95. ℞ Ferri et Ammon. Citrat. ʒij.
Liq. Arsenic. (Fowler) ʒiss.
Glycerini Puri ℥i.
Aquæ *ad* ℥iv. M.

Sig.—One or two teaspoonfuls in water thrice daily after food.

Use—In chronic eczema of auricle or external auditory canal; in recurrent furunculi in external auditory canal; also advocated by some writers as being a useful remedy in tinnitus.

96. ℞ Ext. Aloes
Ferri Sulphatis
Pulv. Zingib. *aa*. gr. i.
Ext. Gentian. *q. s. ut fiat pilula.*

Sig.—One thrice daily.

97. ℞. Tinct. Ferri Perchlorid. ʒij.
Liq. Strychniæ ʒi.
Aquæ *ad* ℥vi. M.

Sig.—A tablespoonful in water thrice daily after food.

(b.) *Remedies employed chiefly where syphilis complicates an ear affection.*

98. ℞ Hydrarg. Iodid. Virid. gr. ss.
Ext. Opii gr. ¼
Conf. Rosæ Gallic. *q. s. ut fiat pilula.*

Sig.—One thrice daily.

99. ℞ Hydrarg. Perchlorid. gr. i.
Potassii Iodid. ʒij.
Tinct. Calumbæ ℥ij.
Aquæ *ad* ℥vi. M.

Sig.—Two teaspoonfuls in a glass of water three times a day.

100. ℞ Potassii Iodid. ʒij.—ʒvi.
Ammon. Carb. ʒi.
Syrup. Aurant. ʒvi.
Infus. Calumbæ *ad* ℥vi. M.

Sig.—A tablespoonful in water thrice daily. Recommended in smaller doses by Politzer for relieving the pain of caries; also recommended in facial paralysis. In larger doses, used in syphilitic disease of labyrinth. In Ménière's disease, doses of eight grains three times a day. May also be tried in suspected paralysis of auditory nerve.

101. ℞ Potassii Iodid. ʒi.
Ferri et Ammoniæ Citrat. ʒij.
Infus. Calumbæ *ad* ℥vi. M.

Sig.—A tablespoonful in water thrice daily.

(c.) *Remedies employed chiefly where scrofula is associated with an ear affection.*

102. ℞ Calcii Sulphid. gr. ¼ *Fiat pilula.*

Sig.—One every four hours.
Use—Said to limit or cut short boils in the external auditory canal.

103. Kepler's Malt Extract with Cod-liver Oil.
Kepler's Malt Extract with Cod-liver Oil and Iodide of Iron.—Cod-liver Oil.

104. ℞ Syrup. Ferri Iodid. ℥ss.
Glycerini Puri ℥iss.
Aquæ *ad* ℥iv. M.

Sig.—One or two teaspoonfuls thrice daily.

105. ℞ Syr. Hypophosphit. (Fellows) ℥vi.

Sig.—For an adult, a teaspoonful three times a day after food.

106. ℞ Syrup. Phosphat. Co. (Squire) ℥vj.

Sig.—Thirty to sixty minims in water thrice daily.
Formerly called "Parrish's Syrup" or "Chemical Food."

107. ℞ Potassii Iodid. gr. viij.
Ferri et Ammoniæ Citrat. gr. xxiv.
Syrup. Simp. ℥i.
Aquæ *ad* ℥iv. M.

Sig.—For children, one or two teaspoonfuls thrice daily.

(d.) *Aperients and antacids.*

108. ℞ Hydrarg. *c.* Cretâ gr. i.
Sodæ Bicarb. gr. ii.
Pulv. Rhei gr. iij. M.

Fiat pulvis—Suitable aperient and antacid for a child. Larger doses according to age.

109. ℞ Pilulæ Hydrargyri.
Pilulæ Rhei Comp.
Extracti Hyoscyami *aa.* gr. xx. M.

Divide in pilulas Xij.
Sig.—Two to be taken occasionally at bedtime.

110. Hunyadi János, Püllna, or Friedrichshall Bitter Water. Half a tumblerful filled up with hot water in the early morning.

Use — Frequently beneficial in allaying subjective sounds in the ear.

111. ℞ Bismuth. Carb. ʒiss.
Potassæ Bicarb. ʒij.
Inf. Calumbæ *ad* ℥vi. M.

Sig. — A tablespoonful in a glass of water thrice daily.

112. ℞ Magnesiæ Carb. ʒiss.
Magnesiæ Sulphatis ʒiv.
Tinct. Cardam. Co. ʒiij.
Tinct. Zingib. ʒiij.
Aquæ Menthæ Pip. *ad* ℥vi. M.

Sig.—A tablespoonful in a glass of water twice daily.

(e.) *Diaphoretics or sedatives.*

113. ℞ Pulv. Ipecac. Co. gr xij.
Full dose for an adult.

Use—In acute naso-pharyngeal catarrh, it may shorten the attack; sometimes required for the relief of painful inflammatory affections of the ear; a diaphoretic dose may abate an inflammatory process in the ear.

114. ℞ Liq. Ammon. Acet. ℥iv.

Sig.—One or two teaspoonfuls every two hours.

Use—In acute naso-pharyngeal catarrh it may shorten the attack; if it produces free action of the skin it may tend to abate an inflammatory process in the ear.

(f.) *Special remedies chiefly employed for the relief of subjective sounds in the ear.*

115. ℞ Tinct. Arnicæ ʒiv.
Glycerini Puri ʒvi.
Aquæ *ad* ℥iv. M.

Sig.—Two teaspoonfuls in water three times daily.

Use—Recommended by some writers for tinnitus aurium.

116. ℞ Zinci Valerian.
Ext. Conii *aa.* gr. ij. M. *Fiat pilula.*

Sig.—One pill morning, midday, and evening.

Use—Has been found beneficial in relieving some forms of tinnitus aurium.

117. ℞ Zinci Valerian. gr. ij.
Ext. Nucis Vomic. gr. ¼
Ext. Gentian. gr. ij. M.
Fiat pilula.

Sig.—One three times daily.

Use—Same as above.

118. ℞ Ammon. Chlorid. ʒiv.
Ext. Glycyrrh. Liq. ℥i.
Aquæ *ad* ℥vi. M.

Sig.—Two teaspoonfuls in water thrice daily.

Use—Has a mitigating influence upon some forms of tinnitus aurium.

119. ℞ Acid. Hydrobromic. ʒiv.
Aquæ *ad* ℥iv. M.

Sig.—Two teaspoonfuls three times a day.

Use—In certain forms of tinnitus aurium this remedy has a beneficial effect.

120. ℞ Potassii Bromid. gr. xx—ʒi.

Sig.—Dissolve in a large quantity of water and take at night.

Use—Should be employed if cerebral symptoms arise in connection with ear disease; also in severe forms of tinnitus, especially when associated with nervous excitement, drachm doses at bedtime may give great relief.

121. ℞ Infus. Digitalis ℥iv.

Sig.—Two teaspoonfuls thrice daily.

Use—In pulsating forms of tinnitus aurium.

122. ℞ Quiniæ Sulph. gr. xij.—ʒi.
Syr. Aurant. ʒvi.
Aquæ *ad.* ℥vi. M.

Sig.—A tablespoonful for a dose after shaking up the mixture.

Use—In smaller doses every three or four hours, given in simple otalgia; the larger doses to be given every two or three hours in phlebitis, thrombosis, or pyæmia; also in Ménière's disease after the first few weeks.

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